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OSTEOLOGY OF BAPTANODON (MARSH).

By C. W. Gilmore.

Introduction.

The discovery of the existence in the Jurassic of North America of a representative of the Ichthyosaurian reptiles was first announced by Professor O. C. Marsh in 1879.[1] Although fossil remains of these animals are very abundant in Europe where they have attracted the attention of naturalists for the past two centuries, with one exception[2] it was not until this late date that they were reported from this country. Notwithstanding that continued explorations in the Jurassic have brought to light many representatives of this group, with the exception of a few short papers nothing has been published concerning the skeletal features of these interesting reptiles.

The skeletons are usually imbedded in exceedingly hard and refractory concretions and the bone is so thoroughly impregnated with the matrix, which it closely resembles in color and texture, that the work of preparation is exceedingly tedious. The difficulty in preparing the material for study may in a measure account for the apparent neglect of this group.

The Jurassic Ichthyosaurian material preserved in the vertebrate collections of this museum has been largely gathered by the different field parties which have been operating for the past five seasons in the fossil deposits of the west.

Through the courtesy of Mr. J. B. Hatcher, late Curator of the Department of Vertebrate Paleontology of the Carnegie Museum, this material has been placed at the disposal of the writer for study and description.

[1] Marsh, O. C., "A New Order of Extinct Reptiles (*Sauranodonta*) from the Jurassic of North America," *Amer. Jour. Sci.* (3), Vol. XVII., pp. 85–86, January, 1879.

[2] Leidy, Joseph, "Notice of Some Reptilian Remains from Nevada," *Proc. Acad. Nat. Sci. Phila.*, Vol. XX., pp. 177, 178, 1868. A Triassic form.

The present paper is based upon the remains of three individuals, Nos.[3] 603, 878 and 919, from as many widely separated localities. All have been entirely freed from the matrix or worked out in relief by the writer and because of their remarkably well preserved condition several important osteological characters are shown for the first time.

In studying this material it was found necessary to compare it with the types of *Baptanodon*, preserved in the Yale Museum collections. Through the kindness of the late Dr. C. E. Beecher the author was permitted to study not only the types (*B. natans* and *B. discus*), but all of the Ichthyosaurian remains contained in the collections of that museum, comprising parts of some nine or ten individuals. At the American Museum of Natural History through the courtesy of Dr. W. D. Matthew I was given the privilege of examining the quite complete Jurassic Ichthyosaurian skeleton in that collection. Through my former instructor, the late Dr. W. C. Knight, I was accorded the privilege of studying the material at the Wyoming University, Laramie, Wyoming, part of which I helped collect. Thus practically all of the important Ichthyosaurian remains known from the Jurassic of North America have been personally examined during the preparation of this paper.

My acknowledgments are especially due the late Mr. J. B. Hatcher for the encouragement and kind consideration shown me in all matters pertaining to the preparation of this study.

For the preparation of the drawings used the author is grateful to the skill and patience of Mr. Sidney Prentice.

The photographs are by Mr. A. S. Coggeshall.

Occurrence and Distribution.

The Ichthyosaurian remains collected from the Jurassic of America have all been found in the upper part of the marine division of that formation. This marine strata was designated by Marsh as the *Baptanodon Beds*,[4] and included all of the Jurassic lying between the freshwater or *Atlantosaurus Beds* above and the red beds or *Triassic* (?) below. The *Hallopus Beds* of Marsh, if at all recognizable, have never been found in contact with the marine beds and their exact position in relation to these beds is yet undetermined.

Knight[5] has proposed the name Shirley for the marine series without assigning any place or giving any reasons for supplanting the old and generally accepted term *Baptanodon Beds*, which has priority.

[3] The numbers refer to the Card Catalogue of Fossil Vertebrates in the Collection of the Carnegie Museum.

[4] Marsh, O. C., "The *Reptilia* of the Baptanodon Beds," *Amer. Jour. of Sci.* (3), Vol. 50, pp. 405–406, 1895.

[5] Knight, W. C., Jurassic Rocks of Southeastern Wyoming," *Bull. of the Geol. Soc. of America*, Vol. XI., pp. 377–388, May, 1900.

Dr. F. B. Loomis[6] in a later paper proposes to confine the term *Baptanodon Beds* to the single layer in which the remains of these reptiles are found. Hatcher[7] has justly contended that the duplication by giving new names to old and well known formations, "tends to augment still further the confusion which already exists in our geologic formation names," and this would appear to be another instance in which the old and generally accepted term should be retained in its original meaning.

These beds have been briefly described by Knight as follows:[8] "Composed of bands of shale, limestone, sandstone, and clay. The limestones are usually shaly. The limestone beds are quite thin, but usually fossiliferous. The clays and shales usually contain large concretions which contain both vertebrate and invertebrate fossils. Septaria are common. The invertebrate as well as the vertebrate faunas are only partly known. This has been largely due to the fact that the richest fossil localities are where the concretions are well developed and until recently not many of these were known."

The following is a fairly complete list of the fossils described from the marine Jurassic of this country.

INVERTEBRATES.

Astarta packardi, White.
Belemnites densus, M. & H.
Cardioceras eardiformis, M. & H.
Cardioceras eardiformis, var. *distans*, Whitf.
Comptonectes bellistriata, Meek.
Comptonectes extenuata, M. & H.
Gryphæa nebrascensis, M. & H.
Dentalium subquadratus, Meek.
Goniomya montanaensis, Meek.
Grammatodon inornatus, M. & H.
Lima sp.
Lingula brevirostris, M. & H.
Modiola sp.
Ostrea engelmanni, Meek.
Pentacrinus asteriscus, M. & H.
Pholodomya kingi, Meek.
Pleuromya subcompressa, Meek.
Pinna sp.
Pseudomonotis curta, Hall.
Pseudomonotis orbiculata, Whitfield.
Tancredia cf. *extensa*, White.
Tancredia cf. *inornata* (M. & H.), Whitf.
Tancredia warrenana, M. & H.
Thraeia weedi, Stanton.

VERTEBRATES.

Baptanodon natans, Marsh.
Baptanodon marshi, Knight.
Baptanodon discus, Marsh.
Cimoliosaurus laramiensis, Knight.
Megalneusaurus rex, Knight.
Plesiosaurus shirleyensis, Knight.
Pantosaurus striatus, Marsh.

[6] Loomis, F. B., "On Jurassic Stratigraphy in Southeastern Wyoming," *Bull. of Am. Museum of Nat. History*, Vol. XIV., article XII., pp. 189–197, June, 1901.

[7] Hatcher, J. B., *Memoirs of Carnegie Museum*, Vol. II., No. 1, November, 1903, p. 67.

[8] *Lit. cit.*, p. 385.

Two fishes have been referred to by Knight as probably coming from these beds.

Amiopsis dartoni, Eastman. *Pholidophorus americanus*, Eastman.

Hatcher[9] gives the geographical extent of these beds as follows: "The marine *Baptanodon Beds* throughout Wyoming and South Dakota are everywhere found accompanying and underlying the freshwater *Atlantosaurus Beds* though thinning out toward the south and entirely disappearing as we approach the Wyoming and Colorado state line." He has also shown that the lowermost 150 feet of the Jura at Cañon City, Colorado, may be the freshwater equivalents of the marine *Baptanodon Beds* farther north.

By far the largest number of skeletons of *Baptanodon* now known have been collected from the exposures of southeastern Wyoming, though several individuals have been discovered in the strata farther north. There is one specimen (No. 919) in the collections of this museum from the marine beds of north central Wyoming. Their remains are also reported from South Dakota.

Of the dozen or more specimens I have collected or helped collect every one was found more or less enclosed in one of those concretionary masses spoken of by Knight, the form and size of these concretions being dependent upon the shape and position of the skeleton enclosed. When exposed to the atmosphere, as often happens by the carrying away of the surrounding shale or clay, the concretion invariably cracks into an innumerable number of pieces.

It has been my experience that the anterior portion of the snout, the end of the tail and tips of the extremities are not enclosed by the concretion, and when present are found in the soil surrounding the rock. This will account for the poorly preserved condition of these parts in the material under discussion. Of the six skulls and parts of skulls examined the tip of the beak is wanting in every instance, and peculiar as it may seem, the anterior fourth of each protruded from the concretion into the surrounding shale. The quite complete posterior caudal series preserved in the collection of the University of Wyoming came from the clay. Four paddles have been studied and although the bones of the proximal segments are retained in their relative positions in the matrix, the distal part is wanting in every instance. In one example, the type of *B. discus* (No. 1955),[10] quite a number of the smaller or distal disks were preserved but their color and state of preservation indicated that they had come from the soft clay surrounding the concretion which contained the skeleton proper.

[9] *Lit. cit.*, p. 70.

[10] Catalogue number of the Yale Museum.

So far as I am able to learn there has never been more than a single individual found in any one of these concretions.

Plate VII. shows the outline of the concretion with the bones of specimen No. 878 in their relative positions as they lay imbedded in the matrix. The skull was lying on the right side and turned at a right angle to the vertebral column.

The snout projected from the concretion as explained above. The cervicals immediately following the atlas and axis were crushed into the left orbit so completely that it was deemed inadvisable to attempt their removal. In the course of preparation the skull has been separated from the block containing the other parts of the skeleton. Though slightly displaced the anterior 15 vertebræ are well preserved. The remaining six of the series are only represented by fragments and these are of little value for purposes of study.

The coracoids and scapulæ, as will be seen, were in their natural positions and give an accurate idea of the manner in which they articulated. The clavicles and interclavicle were somewhat removed from the remainder of the girdle, though the relation of these bones is very well shown. There are many parts of ribs but none are complete. The proximal end of the right humerus is the only limb bone represented and this end was only slightly removed from the glenoid socket.

The bones shown in this diagram will be referred to later in the detailed description of the several parts.

This specimen (No. 878) was collected by Dr. J. L. Wortman and party during the summer of 1899 on Troublesome Creek, Carbon Co., Wyo. It is the most complete individual of the three considered in this paper, and is unique as being the first to have the clavicles and interclavicle preserved. The parts of this skeleton preserved consist of a good skull and lower jaws, with a series of 21 vertebræ immediately posterior to the skull, the complete pectoral girdle, with the proximal extremity of the right humerus, numerous parts of ribs and isolated paddle bones.

The second individual (No. 603)[11] is from the *Baptanodon Beds* of Sheep Creek, Albany Co., Wyo. It was collected by Mr. O. A. Peterson and party during the season of 1900. The parts recovered consist of a nearly complete skull and lower jaws, numerous vertebræ and pieces of ribs, with a few paddle bones.

(No. 919) is from the Red Fork of Powder River, Big Horn Co., Wyo., and was collected by Mr. W. H. Utterback in 1902. The incomplete pectoral girdle and numerous vertebræ are represented. The dorsal and anterior views of the girdle are shown in Pl. XII.

[11] Hatcher, J. B., "The Carnegie Museum Paleontological Expeditions of 1900," *Science*, N. S., Vol. XII., No. 306, pp. 718–720, Nov., 1900.

Considering our limited knowledge of the structure of the Jurassic Ichthyosaurians, I shall figure and describe this material in detail.

The following description of the several elements is based largely on No. 878 supplemented by such characters as are shown by Nos. 603 and 919. Unless otherwise stated the material should be considered as pertaining to No. 878.

THE SKULL. (Pl. VIII.; Pl. IX., Figs. 1 and 2; Pl. X., Figs. 1 and 2; Pl. XI., Figs. 1 and 2.)

In general form the skull of *B. discus* bears a close resemblance to the other members of the Ichthyosauria. This is strikingly illustrated by the position and enormous size of the orbit, the presence of ossified sclerotic plates, the elongated nasals and premaxillaries and the reduced maxillaries.

Seen from the side the skull[12] is triangular in outline. The anterior portion is formed by the elongated rostrum observed also in many of the European species. The orbital opening is a conspicuous feature of this aspect of the skull; it is very large and nearly circular in form; its greatest vertical diameter is 241 mm. the horizontal diameter being 234 mm. It is enclosed above by the post- and pre(?)-frontals, posteriorly by the postorbital, below by the jugal, and anteriorly, chiefly by the lachrymal. Just anterior to the orbit is the obliquely placed narial opening. In skull No. 603 these openings appear to be more nearly horizontal (see Pl. X., Fig. 2) as is generally observed in *Ichthyosaurus*. The nares are bounded by the nasals, prefrontals (?), lachrymals, maxillaries, and premaxillaries.

Viewed posteriorly (see Pl. XI.) the skull is subrectangular in form being wider than high. This aspect shows this region to be more compactly and firmly constructed than in any known form of the Ichthyopterygia. The arrangement of the opisthotics and stapes is such as to give the greatest strength and rigidity to this region. They act as braces from the basioccipital as a fixed point to all four angles of the skull. In comparing this view of the skull of *Baptanodon* with those of *Ichthyosaurus* as shown by Cuvier,[13] Owen,[14] Cope,[15] Frass,[16] Bauer[17] and Woodward,[18]

[12] All drawings of the skull with the exception of the inferior view, Plate IX., Fig. 2 (No. 603), have been made from specimen No. 878, though for the sake of completeness, elements and sutures not discernible in this specimen, when present, have been supplied from No. 603. Whenever such use has been made mention is given in the detailed description of the elements to appear later. Dotted lines indicate the probable position of sutures not shown by the material at hand.

[13] Cuvier, R., "Ossemens Fossiles," Vol. 6, Plate XXIX.

[14] Owen, R., "Monograph of Fossil Reptilia of the Liassic Formations," Pt. III., Plate XXVI.

[15] Cope, E. D., "On the Homologies of some of the Cranial Bones of the Reptilia," *Proc. Am. Assoc.*, Vol. XIX. fig. 2, p. 199.

[16] Frass, E., "Die Ichthyosaurier der Süddeutschen Trias und Jura Ablagerungen," Plate II., figs. 3–8.

[17] Bauer, Franz, *Anatomischer Anzeiger*, Vol. XVIII., p. 586, fig. 17, 1900.

[18] Woodward, A. S., "Vertebrate Palæontology," fig. D, p. 178.

the great solidity of the former contrasts strongly with the loose and weak arrangement seen in the latter.

The foramen magnum is the largest opening in this view of the skull. It is subelliptical in form with the greatest diameter vertical. The opening is bounded by the basi-occipital below, exoccipitals and supraoccipital laterally, and supraoccipital above. There may have been a foramen, see Pl. XI., figs. 1 and 2, between the exoccipital, opisthotic, parietal and squamosal, though this cannot be absolutely determined from the material at hand. The small elongate opening formed by the quadrate and quadratojugal is the "auditory meatus" of Owen.

The superior view of the skull has the triangular form seen in the lateral aspect. Posteriorly on either side of the brain case are the large temporal vacuities surrounded by the squamosals, parietals, post- and pre-(?) frontals. It will be noticed that the sutures between the parietals, frontals and posterior part of the nasals, as indicated by the dotted lines are obliterated in these specimens. A pineal foramen appears to be present in both of the skulls before me.

The inferior region posteriorly is well preserved in both skulls but more anteriorly the determination of the different elements has been rendered difficult by the crushing to which the specimen was subjected.

The palate view as shown in Pl. IX., fig. 2, has been drawn almost entirely from the skull pertaining to specimen (No. 603).

Medially there is the long interpterygoid vacuity enclosed laterally by the inner borders of the pterygoids and posteriorly by the basisphenoid. This vacuity is divided posteriorly by the long slender process of the presphenoid.

Because of the close attachment of the lower jaw the size and extent of the pterygomalar vacuity cannot be determined from these skulls. Owing to lateral compression the posterior nares have been nearly closed and their exact shape cannot be determined.

MEASUREMENTS OF THE SKULLS.

No. 878.	Greatest length of skull	1082 mm.
" 603.	" " "	1028 "
" 878.	" width "	315 "
" 603.	" " "	222 "
" 878.	" height "	320 "
" 603.	" " "	295 "

Basioccipital (*b.occ.*). — The basioccipital is a short heavy bone the most robust element of the posterior portion of the skull. It extends backward forming a subcircular convex condyle, which superiorly is separated from the foramen magnum by a very narrow nonarticular tract. This tract as it descends is concave and gains breadth in flaring out to meet the investing bones. As usual it is separated from the articular tract of the condyle below by a very shallow groove. In both specimens (Nos. 603 and 878) inferiorly there is a very prominent transverse dividing line, which probably represents the deep vertical suture between the basioccipital and basisphenoid. In either instance however the size of the suture has probably been exaggerated somewhat by crushing. On the median neural surface there is a shallow antero-posterior channel which forms the basal boundary of the foramen magnum, and on either side are deep excavations for the sutural articulations with the exoccipitals. These elements do not enter into the composition of the occipital condyle as in some reptiles.

Principal measurements are as follows:

No. 878.	Greatest breadth of occipital condyle	65 mm.
" 603.	" " " "	65 "
" 878.	" depth " "	58 "
" 603.	" " " "	64 "
" 878.	" breadth of basioccipital	90 "
" 603.	" " "	90 "
" 878.	" depth "	74 "
" 603.	" " "	85 "
" 878.	" length "	60 "
" 603.	" " "	62 "

Exoccipitals (*ex.occ.*). — These elements viewed from the back are seen as two small subrectangular bones that rise from the superior surface of the basioccipital to support the heavy inverted U-shaped supraoccipital. The interior margins of these bones form the walls of the lower third of the foramen magnum. Below the articular ends are somewhat enlarged for the strong sutural articulation with the basioccipital. The external surfaces are very slightly concave transversely. These elements do not show the lateral excavations seen in the exoccipitals of *Ichthyosaurus*, but apparently there is a foramen at this point as in the former genus though this cannot be definitely determined from our specimens.

MEASUREMENTS.

No. 878.	Greatest length of exoccipital	34 mm.
" 878.	" breadth "	25 "

Supraoccipital (*s.occ.*). — Of the four bones forming the boundary of the foramen magnum the supraoccipital contributes the greater part. This element as seen posteriorly has the form of an inverted U, the stems of which articulate with the exoccipitals. The supraoccipital of *B. discus* differs materially from the corresponding element in *Ichthyosaurus*. In the latter genus the supraoccipital is a remarkably massive bone which only enters slightly into the formation of the foramen magnum, hardly more than arching over the superior boundary.

The supraoccipital and exoccipitals do not maintain a vertical position as in most reptiles, but are inclined forward at a considerable angle. The superior and lateral surfaces of the former being wedged in between and under the overlying parietals, not grown fast with them but as in *Ichthyosaurus* only held there by ligaments or cartilage. The posterior face from the edge of the foramen to where it passes under the parietals presents a slightly rounded surface. On the superior median surface this element is slightly enlarged, see Pl. XI., fig. 1 and 2, resembling somewhat the complete symphysis of a suture, which suggests the idea that these elements might have been paired at one time. The articular ends are triangular in form with the central portion slightly concave.

It may be of interest to note that the part this element takes in the formation of the foramen magnum, *i. e.*, the triangular form of the articular face for the exoccipital and the suggestion of having been paired at one time, it resembles the Plesiosaur (*Dolichorhynchops osborni*)[19] more than any other form of reptile that has come under the observation of the writer.

MEASUREMENTS.

No. 603.	Greatest height of supraoccipital	70 mm.
" 878.	" " "	65 "
" 878.	" width "	26 "

Opisthotic[20] (*op.o.*).—The opisthotics are two subcylindrical bones that extend outward and upward from the lateral superior surfaces of the basioccipital, broadest where they meet the basioccipital, exoccipital and stapes, constricted medially, again expanding into a rounded end which abuts against and between that portion of the squamosal where it divides into a superior and inferior branch. The squamosal really encloses the upper half of these elements. The lower articular end has three distinct articular faces which unite with the exoccipital, basioccipital and stape respectively. It will be observed in Pl. XI., fig. 1, that the right opisthotic is somewhat removed from what I have considered as the normal position shown by the left element. The relations and shape of these elements differ considerably from the opisthotics in *Ichthyosaurus*. Here we find the upper or superior end articulating with the squamosal and not free as shown by most of the illustrations of this view of the skull of *Ichthyosaurus*.

[19] Williston, S. W., "North American Plesiosaurs," Part I., Field Columbian Museum, Publication 73, Geol. Series, Vol. II., No. 1, fig. 3, p. 27.

[20] It has been shown by Dr. S. W. Williston that this element if a single bone should be called the paraoccipital which is the older name given to this bone by Owen in 1838. But until better understood I use the generally accepted term opisthotic, *lit. cit.*, p. 25.

In *Ichthyosaurus* the lower articular end is shown as only articulating with two bones, the basioccipital and exoccipital, the stronger surface being opposed to the latter. In *B. discus*, as has been indicated above, this bone articulates with three elements the longest face being opposed to the basioccipital.

Woodward [21] shows the opisthotic of *I. longifrons* as articulating exclusively with the exoccipital and instead of extending outward and upward, it is inclined outward and slightly downward reaching the inner border of the quadrate. In his diagram the stapes are absent. Frass [22] gives a posterior view of the skull of *I. quadrissicus* in which the opisthotic articulates medially with the exoccipital and slightly if at all with the basioccipital. Outwardly the upper end is free. In this species the parietal is interposed between the free end of the opisthotic and the squamosal. Cope's [23] diagram of this view of the skull of *Ichthyosaurus* approaches the form under consideration more nearly than any brought under the writer's observation. Though Cope was probably mistaken in the placing of the stapes as not articulating with the basioccipital.

MEASUREMENTS.

No. 878.	Greatest length of opisthotic	60 mm.
" 878.	" breadth distally of opisthotic	40 "
" 878.	" " proximally of opisthotic	27 "

Stapes (*st.*).—The stapes are two trihedral bars that extend downward and outward from the lateral inferior borders of the basioccipital. The superior or articulating end is the most expanded, being divided into two distinct articular faces. The upper face is opposed to a similar articular surface on the opisthotic at about the middle of the side of the basioccipital. The lower articular surface is in contact with the lower side of the basioccipital. The outer end of this bone is slightly expanded and rests in a groove on the inner lower posterior surface of the quadrate. The position assigned it by Baur[24] in the Ichthyosauria. Seen posteriorly the surface is slightly rounded. Viewed from the outer end this bone is triangular in form. Above, the inferior bar of the squamosal comes down and passes under the superior lateral margin. The lower side apparently, rested upon the posterior superior surface of the pterygoid. The foramen shown in all posterior views of the skulls of Ichthyosauria which I have studied appears to be entirely closed by the inferior branch of the squamosal in *B. discus*. Although by an examination of the different views referred to above, hardly any two agree in the exact shape and position of these

[21] Woodward, *lit. cit.*, p. 178, fig. 111.

[22] Frass, *lit. cit.*, Plate II., figs. 3–8.

[23] Cope, *lit. cit.*, p. 199, fig. 2.

[24] Baur, G., "On the Morphology and Origin of the Ichthyopterygia," *Amer. Nat.*, Vol. XXI., 1887, p. 837.

openings, furthermore, it would appear that nearly if not all of these figures are either diagrammatic or drawn from reconstructed material which may explain some of the otherwise unaccountable differences, not only between the forms of the two genera compared here, but in species of the genus *Ichthyosaurus*. Differences which if present should certainly be considered as of more than specific importance.

Cope[25] in 1870 was the first to recognize and correctly determine the opisthotic and stapedial bones in *Ichthyosaurus*. Since then, however, as shown above some authorities have given posterior views with the stapes absent.

MEASUREMENTS.

No. 878.	Greatest length of stapes	70 mm.
" 878.	" breadth of proximal end	47 "
" 878.	" " distal end	25 "

Squamosal (*sq.*).— In the nomenclature of this bone the usual determination is followed. Both Baur and Merriam reverse the names of the two bones here designated as *squamosal* and *supratemporal*. The element here called squamosal is the *mastoid* of Owen.

The squamosal is a large irregular triradiate bone, the upper part of which forms the superior posterior angle of the cranium. From a posterior obtuse central portion three branches are given off. The internal branch, the most robust part of the element extends forward and upward from the angle of the skull to meet the lateral posterior margin of the descending parietal. Superiorly the surface is thickened and rounded and forms the posterior boundary of the supratemporal fossa. Seen posteriorly it is a flattened subtriangular plate the base of which laps over the upper lateral margin of the opisthotic. The inferior plate superiorly is deeply indented by the intrusion of the superior end of the opisthotic, or in reality this element is opposed to the squamosal at the junction of the internal and inferior parts. The inferior branch as it descends widens into a broad flat plate that completely fills all of the space between the opisthotic, stapes and quadrate, its lower extremity passing under the upper lateral margin of the stapes. The outer border unites with the inner border of the quadrate for the greater part of its length. Medially this plate is inclined forward, its inner margin underlapping both the opisthotic and stape. The superior outer margin is continued upward along the quadrate to meet the supratemporal at the angle of the skull. The anterior branch of the squamosal is greatly compressed from side to side. This thin plate is directed forward and inward, and forms about one half of the outer boundary of the temporal fossa. Although it is produced along the inner side of the postfrontal by an elon-

[25] Cope, E. D., *lit. cit.*, p. 247.

gated suture, this part inferiorly meets the supratemporal and the posterior portion of the postfrontal. The squamosal as in Reptilia and Batrachia generally forms part of the combination which supports the quadrate. This bone articulates with the quadrate, parietal, opisthotic, supratemporal and postfrontal.

MEASUREMENTS.

No. 878.	Greatest length of anterior branch of squamosal	128 mm.
" 878.	" " internal " "	76 "
" 878.	" " inferior " "	90 "

Supratemporal (*s.t.*). — The supratemporal is an irregular subtriangular bony plate that is wedged into the interspace between the squamosal, post-frontal, post-orbital, quadratojugal and quadrate. Externally the surface is slightly convex. This bone represents the *prosquamosal* or *supersquamosal* of Owen, the *temporal* of Cuvier, the *squamosal* of Baur and Merriam, and the *supraquadrate* of Seeley; the latter name being given because it rests upon and hides from lateral view the upper portion of the quadrate. The terms enumerated have been used in describing the more primitive forms contained in the genera *Shastasaurus* and *Ichthyosaurus*.

Quadrate (*qu.*). — The quadrate viewed posteriorly is a flat narrow vertical plate with the external margin excavated. In conjunction with the quadratojugal it enclosed the auditory opening as in *Sphenodon*. Superiorly this element meets the supratemporal and squamosal, the latter assuming the greater part of the articulation as will be found to be the case in most of the Ichthyosaurs. The quadrate expands distally into a heavy transverse articulation for the lower jaw.

In specimen No. 878 the lateral separation between the quadrate and inferior branch of the squamosal is distinctly shown on both sides of the skull, see Pl. XI., fig. 1, but on the left side of the skull of No. 603 the suture has become obliterated and the two bones thus united form a continuous broad plate of bone. Distally the external concave border turns abruptly outward. It is upon this border just internal to the articular end that the infero-posterior angle of the quadratojugal rests. The lower internal border of the quadrate unites closely with the postero-lateral process sent off by the pterygoid. On the lower posterior surface there is a slightly roughened groove which received the lower or distal end of the stapes. These elements have been somewhat displaced by crushing, and their normal relations cannot be definitely determined, though the presence of this groove has convinced the writer that the above was undoubtedly their natural position. See Pl. XI., fig. 2.

Specimen No. 603, which has the posterior portion of the right ramus wanting, gives a good view of the articular end of the quadrate. It is pentagonal in form, narrower antero-posteriorly than laterally and concave on the inner border where it meets the descending process of the pterygoid.

MEASUREMENTS.

No. 878.	Greatest length of the quadrate	122 mm.
" 878.	" width distal end of the quadrate	50 "
" 603.	" " " " " "	50 "
" 878.	" " antero-posteriorly of the quadrate	43 "
" 603.	" " " " " "	40 "

Quadratojugal (*q.j.*). — The quadratojugal seen from the side is a small triangular bone that connects the jugal and postorbital with the quadrate. The posterior border of this bone is slightly rounded; distally somewhat expanded, thus forming an articular end which meets the outer border of the quadrate at nearly right angles, resting upon this edge just above the heavy articular end of the latter.

The external surface is flat. The opposite side forms the outer boundary of the foramen at this point. Superiorly this element passes under the quadrate and supratemporal, the upper portion being hidden from a side view by the overlying postorbital. The infero-anterior border is united with the jugal by a suture 47 mm. long. The lower border of this bone is 57 mm. in length.

Postorbital (*pto.*).—The postorbital is a more slender element than the jugal, and as Owen[26] has observed "resembles a dismemberment of an ascending process of the malar." Its lower end overlaps and joins by squamous suture the posterior end of the jugal. This suture between the jugal and postorbital is 89 mm. in length, the same as given by Professor Seeley for the corresponding suture in *Ichthyosaurus* (*zelandicus*) *quadriscissus*.[27] As it rises to the middle of the back of the orbit the width remains about the same, above the middle it curves upward and forward along the lower margins of the supratemporal and postfrontal. Above the middle of the orbit the postorbital suddenly expands, then tapers to a slender point that terminates on the lower border of the postfrontal nearly at the top of the orbit. Viewed laterally the surface is slightly concave. The anterior border forms the posterior boundary of the orbit. This bone unites with the jugal, quadratojugal, supratemporal and postfrontal.

Sclerotic plates (*scl.*). — The sclerotic ring is unusally well preserved in at least one orbit of both skulls. In No. 878 the ring is composed of fourteen wedge-like plates, the inner ends being truncated by the pupillary opening.

From the pupillary border the plates extend outward ray-like to the periphery of the eyeball, there bending sharply inward completely enclosing the outer borders.

[26] Owen, R., *lit. cit.*

[27] Seeley, H. G. *Quart. Jour. Geol. Soc., of London*, Vol. XXXVI.

The matrix in this region has not been sufficiently removed to show fully the inward extension of these plates. The surface of each plate is covered with lines that radiate from the center of the plate inward and outward to either lateral border.

The ring is nearly circular in form and almost fills the large orbit. The pupillary opening measures about 100 mm. in diameter, the entire diameter of the ring being 202 mm. The left orbit of No. 603 has the ring nearly as well preserved, though the exact number of plates cannot be ascertained. The outer surface is inclined somewhat from the center to the outer margin and does not present so flat a surface as observed in a specimen (No. 877) of *I. communis* in the collection of this museum. The sclerotic rings do not stand parallel to one another but are inclined inward anteriorly.

Jugal (*j.*). — The jugal is a long curved bar that forms the lower boundary of the orbit. This element in both of the specimens under consideration is unusually strong. Anteriorly the end commences in a tapering point which is wedged in between the lachrymal and maxillary. Medially it widens into a subcompressed bar reaching its maximum width under the middle of the orbit. At this point superiorly the surface is slightly concave but becomes flattened and compressed posteriorly terminating in a wedge-like end which is received between the postorbital and quadratojugal.

Parietals (*pa.*). — In both skulls the median parietal sutures are entirely obliterated. The lateral surfaces which form the outer walls of the brain case are smooth, slightly concave antero-posteriorly and gently convex from the crest downward. The matrix has not been sufficiently removed from the temporal fossa to show the depth of the parietals or their relations to the lower bones of the brain case. The brain case is narrowest just posterior to the middle region but expands both posteriorly and anteriorly. The parietal foramen or pineal eye appears to be bounded posteriorly by the parietals and anteriorly by the frontals. Extending forward and outward from the lateral boundaries of the foramen are the sutures (?) that unite the parietals with the two small frontals. From the antero-internal angle of the temporal fossa the suture between the postfrontal (?) and parietal extends inward and forming an acute angle with the fronto-parietal suture.

The sagittal crest is indicated by a faint ridge posteriorly. The lower posterior border of the parietal rests upon the underlying supraoccipital without sutural junction. The posterior lateral extensions curve downward and backward descending to the top of the exoccipitals, thus contributing to the upper and lateral faces of the occipital surfaces. Seen posteriorly the median portion is slightly thickened, the lateral extremities narrowing somewhat as they descend to occupy the space between the internal branch of the squamosal and the supraoccipital.

Frontals (*fr.*).—The frontals are, so far one may rely on the very unsatisfactory evidence at hand, very small and in a general way resemble those elements observed in the skulls of the *Ichthyosauria* generally. The sutures of this region are quite indistinct being indicated by hardly more than fractures. These fractures however having been produced by pressure would naturally have followed the line of least resistance, which in this case is that of the sutural union of the different elements. As these fractures have the position and direction of the sutures shown in the drawings of Ichthyosaurian skulls I have had them drawn in provisionally. See Plates VIII. and IX. Because of the conjectural nature of the above evidence no attempt will be made to describe this region in detail. This portion of the skull of No. 603 is so badly crushed that all sutures have been entirely obliterated.

Postfrontal (*ptf.*).—The posterior border of this bone is well shown, but anteriorly as explained above the sutures are only indicated by transverse fractures. The post- and prefrontals will be considered here as a single element extending from the supratemporal behind to the rounded fracture forward where it unites with the elongated nasals. Although in *Ichthyosaurus* Frass shows a suture immediately over the eye separating the pre- from the postfrontal, there are no indications of such a suture in our specimens. Reynolds[28] says "The exact position of the suture between the prefrontal and postfrontal is not known." This element as here considered is a moderately long compressed bone forming the quite horizontal postorbital arch. Posteriorly the bone is obliquely inclined so that the outer surface looks outward and upward. Fore and aft the element is convex. The nearly square posterior end unites with the supratemporal, the postero-superior margin with the anterior branch of the squamosal, the latter being prolonged on the inner surface of the postfrontal which is united by an extended suture. The outer or inferior border at this end joins the upper border of the postorbital for about 63 mm., but more anteriorly this bone alone forms the upper boundary of the orbit, at this point assuming a nearly horizontal position. Anteriorly this element acquires its greatest width as it curves in front of the temporal fossa to meet the parietal and frontal. Though how much of this wide portion if any is prefrontal we cannot determine at this time. The superior surface in front of the temporal opening is elevated into a rounded transverse ridge which becomes narrower and somewhat depressed as it approaches the junction with the parietal. Anterior to this ridge the surface is slightly convex transversely and bends downward longitudinally to meet the nasals.

[28] Reynolds, "The Vertebrate Skeleton," p. 196.

Prefrontal (*prf.*).—The shape of the prefrontal, or even the probable outlines, cannot be determined from the present specimens. On the right side of the skull pertaining to specimen No. 878 is a narrow portion forming the upper and forward boundary of the orbit extending down to meet the lachrymal in front. The narrow portion just cited is undoubtedly a part of the prefrontal as this is the position of this element in all fully figured Ichthyosaurian skulls. Although Baur[29] says, "The lachrymal is free from the prefontal in *Ichthyosaurus*, as in many Lacertilians; it is united with this bone in *Sphenodon*."

Nasals (*na.*).—The outline of these bones when viewed from above is triangular. They are elongate antero-posteriorly and form an acute angle where the two elements pass beneath the overlapping premaxillæ as shown by Owen[30] in *I. camplyodon.* The anterior sutural boundaries of these bones are best shown in the skull pertaining to specimen No. 603. Posteriorly and laterally the nasals are bent abruptly downward and form the outer surface of the skull in front of the orbit and above the nares. Anteriorly the outer surface is inclined less obliquely, gradually becoming convex as the nasals extend forward. Above, the nasals are widest at their posterior ends and in so far as one may judge from the damaged condition of this region they were somewhat concave transversely. Posteriorly the nasals united probably with the frontals and the prefrontals (?). The suture separating the nasal from the premaxillary begins at the upper anterior angle of the nasal opening and extends obliquely upward, forward and inward meeting its fellow medially at a point about one third the distance from the anterior to the posterior extremity of the skull. There is a small angular protuberance over the middle of the nares which I have not observed in other Ichthyosaurian skulls. The suture separating the nasals is plainly shown anteriorly in specimen No. 603. In the accompanying figure Pls. VIII. and IX., the anterior sutures have been drawn from that specimen.

Lachrymal (*la.*).—The lachrymal is a large subtriangular bone that joins the prefrontal (?) above and the jugal below to complete the anterior boundary of the orbit. The posterior border is concave. A spine-like prolongation extends backward beneath the eye and unites by suture with the anterior third of the jugal, this border more anteriorly meets the maxillary, terminating at the lower anterior border of the nasal opening. The superior process presumably, meets the prefrontal and nasals above. The latter probably as in *I.* (*zelandicus*) *quadriscissus* sending down a small projection posterior to the narine opening to meet it. Anteriorly the oblique superior border forms the lower boundary of the external nares. The facial surface

[29] Baur, G., *lit. cit.*, p. 838.

[30] Owen, R., "British Cretaceous Reptiles," Monograph, 1851.

posteriorly is somewhat concave and looks outward and baekward; anteriorly it is somewhat rounded, sloping in toward the nasal opening. The inferior side is nearly straight though elevated obliquely from back to front.

Maxillary (*mx.*). — The anterior half of the left maxillary of speeimen (No. 603) was firmly fastened to a seetion of the left ramus by the intervening matrix and being separated from its position in the skull we have a splendid view of the form and structure of the anterior half of this bone. Laterally this element is subtriangular in outline. It eommenees posteriorly under the anterior border of the eye, from whieh it is separated by the anterior portion of the jugal and the posterior braneh of the lachrymal. Anteriorly it expands into faeial, alveolar and palatal aspeets, again tapering out to a slender pointed anterior end. The complete outer anterior view is hidden by the enclosing premaxillary. The median superior margin eontributes a part to the lower boundary of the nasal opening. On the median superior surfaee a long slender horizontal process is developed whieh fits into a eorresponding depression in the premaxillary. The matrix has not been removed suffieiently from the inside to determine whether it articulated with other bones beside the palatines and premaxillaries in that region. Nothing is known of the upper part of the posterior extremity of the maxillary. Anteriorly the superior or articulating surface is rounded, being eovered with longitudinal markings.

The inferior surface anteriorly is eoncave and forms the deepest portion of the alveolar groove.

Premaxillary (*pmx.*). — The premaxillæ are eharaeterized as in nearly all Ichthyosaurians by their great length. In *B. discus* the posterior termination is forked as in many forms of this order. The lower posterior portion enclosed the anterior portions of the maxillary and hides it from a lateral view. From the anterior boundary of the nares the suture between the nasal and premaxillary extends forward and upward to where the opposite branehes beeome eonfluent and cover the anterior extremities of the nasals. The anterior part of the snout narrows gradually to the end and is composed of the premaxillæ alone. The tip as has been already explained is wanting in all of our speeimens. The sides are slightly flattened but above are convexly rounded. The median suture is obliterated in both speeimens although the slipping of the two halves past one another in the skull belonging to No. 878, see Pl. X., fig. 1, indieates that sueh a suture existed. The anterior half of the premaxillary has a longitudinal channel along the side just above the alveolar groove, eontaining pits for the entrance of nerves to the teeth. Deseending to the alveolar surface it will be observed that this element forms the greater portion of the upper jaw. The inner alveolar plate of the premaxillary forms the main part of the arched roof of the upper dental groove. Medially the palatal portion is developed as a long narrow vertical plate that extends downward meeting the same plate of the opposite side mesially for a vertical distance of 12 mm. These narrow alveolar plates posteriorly are separated by the intervention of the anterior extremities of the vomers and pterygoids, which eventually disappear under the premaxillæ.

Basisphenoid (*b.s.*). — In so far as I can ascertain, owing to the damaged condition of this region, the basisphenoid is a heavy subquadrate bone. Posteriorly it articulates with the basioccipital by a deep vertical suture; laterally it is overlapped by the interior processes of the pterygoids; anteriorly the long slender presphenoid is given off. The suture between these bones is not shown nor have I observed it in any of the skulls of *Ichthyosaurus* that are figured. The length of the basisphenoid in specimen No. 603 is about 70 mm.

Presphenoid (*prs.*). — The presphenoid appears as a median anterior prolongation of the basisphenoid. This long trihedral bar gradually tapers to a point as it extends forward. The anterior extremity in No. 603 disappears under the displaced pterygoids. This bone divides the long interpterygoid vacuity into two parts posteriorly.

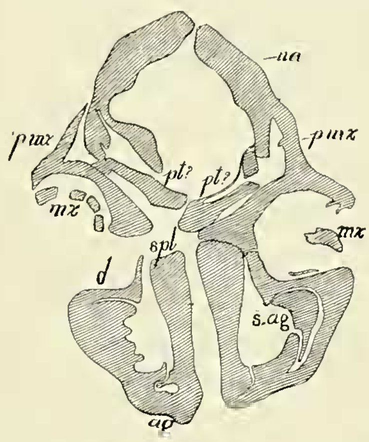
Pterygoid (*pt.*). — The pterygoid is an irregular elongate bone the most conspicuous element of the palatal region. The internal border posteriorly is concave antero-posteriorly and forms the lateral boundary of the interpterygoid vacuity. Posteriorly the inner margin is beveled off to a thin edge which laps over the lateral inferior surfaces of the basisphenoid, and the truncated posterior interior angle probably reached and overlapped the anterior portion of the basioccipital. The posterior end curves slightly upward where the superior surface meets the inferior lateral border of the stapes. Seen from below the posterior border is slightly emarginate, the lateral border posteriorly being deeply excavated. Between this excavation and posterior emargination the pterygoid develops a process that extends outward and downward and laps along the inner inferior one fourth of the quadrate. Anterior to this lateral notch the bone again expands, the lateral extent of which is hidden by the posterior portions of the lower mandible. More anteriorly this element is again excavated by a suture that extends inward and forward, and it is by this suture that the palatines (of modern nomenclature, *transverse bones* of Seeley and Frass, the *ectopterygoid* of Owen), are united with the pterygoids. From this point the latter extend forward and inward, meeting medially, the anterior tapering extremities finally disappearing under and between the vomers. The surfaces of the pterygoids are smooth, both of which dip at a slight angle toward the center of the palate.

Palatines (*pl.*). — The palatines are next in size to the pterygoids of the bones of the palate. They are flat plate-like elements that unite posteriorly with the pterygoids and laterally with the pterygoids and vomers. The outer and anterior extent of these bones cannot be satisfactorily determined from our specimens.

Vomers (*v.*). — These elements are only shown in one specimen, No. 603. Those parts interpreted as vomers are two narrow rod-like bones that begin along the outer anterior margins of the pterygoids. Anteriorly they follow the outline of the skull gradually converging toward one another finally meeting on the median line just before they disappear under the premaxillæ.

There is no evidence of a bone between the vomer and palatine as shown by Frass[31] in *Ichthyosaurus*.

Mandible. — The mandible appears essentially like that of *Ichthyosaurus*. It consists of five and probably six pairs of bones, the dentary, articular, angular,



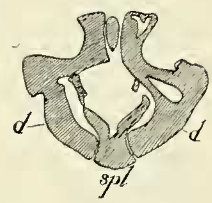


FIG. 1. Cross-section of upper and lower jaws (No. 603), taken at the fracture just above the figure 2 seen in the lateral view of the skull, Plate X. One half natural size. *ag.*, angular; *d.*, dentary; *mx.*, maxillary; *na.*, nasal; *pmx.*, premaxillary; *pt. ?*, pterygoid; *s.ag.*, surangular; *spl.*, splenial.

FIG. 2. Cross-section of the lower jaw of the same taken just anterior to the union of the two rami. One half natural size. *d.*, dentary; *spl.*, splenial.

surangular, splenial and coranoid (?) respectively. The element here called splenial is the operculær of Frass.

Dentary (*d.*). —The most anterior and largest of the bones of the lower jaw is the dentary. It forms the greater part of the fore portion of the lower mandible. The posterior extremity ends under the orbit, its posterior suture running obliquely from below the maxillary to a little beyond the posterior end of the symphysis on the lower border. The superior side forms the shallow alveolar channel in which the teeth are supported. (See figs. 1 and 2.) Posteriorly, the thin inner wall of the

[31] Frass, E., *lit. cit.*, Pl. II., fig. 2.

groove is supported by the quite heavy vertical plate of the splenial, but anteriorly the latter element is supplanted by the higher and thicker inner wall of the dentaries which here exceeds, the outer in height. In specimen No. 878 this inner wall, both at the anterior and posterior parts of the channel, shows some faint vertical ridges, indicative of alveolar compartments. Viewed from below the antcrior portion of the dentaries is evenly rounded. Just below the outer alveolar border is a shallow channel into which several vascular foramina open at the anterior end of the jaw.

Splenial (*spl.*).—The splenial in *Baptanodon* as in the other members of this family is a long vertical plate that is applied to and forms the greater portion of the inner surface of the posterior part of the ramus. The anterior portion extends below the dentary a little and is visible from a lateral view of the mandible. Anteriorly it meets its fellow medially where they unite and pass between and under the dentaries. These appear to be ankylosed at the symphysis. (See fig. 2.) Posteriorly the lower margin of the splenial is gradually confined to the inner side and rises obliquely for a considerable distance. This suture at the posterior end of the jaw is obscure and the boundary between the splenial and coranoid (?) cannot be determined, but the latter element probably continues to the end of the ramus, lapping along the inner side of the articular, assisting the angular and surangular in holding that element in position. (See Pl. XI., fig. 2.) On the internal surface, just posterior to the symphysis is an elongated oval foramen that probably represents the "internal mandibular foramen" of the crocodile, though in this case it appears to be wholly enclosed by the splenial while in the crocodile the splenial only forms the anterior border. Posterior to this foramen, from a point on the lower inner side of the mandible, radiating linear impressions extend forward and upward to the posterior border of the vacuity. They would seem to indicate a surface for muscular insertion.

Surangular (*s.ag.*).— Viewed laterally the surangular is a long slightly-bent bone that forms the upper posterior margin of the ramus. On its inner posterior side this bone develops a concave surface (see *sq.*, fig. 3) which with the anterior end of the articular forms the articulating surface for the quadrate. Just in front of this articulating surface is a node-like protuberance which Frass has pointed out as an arrangement to prevent the dislocation of the lower jaws. (See fig. 3.)

The posterior part of the suture between the angular and surangular is not shown by this material, though it is indicated by a dotted line, after the fractures on the rami of No. 878 which were considered as taking the course of these breaks. Anteriorly the surangular gradually tapers to a point which from a lateral view disappears between the dentary and angular just below the nares, although the elements are continued still farther forward on the inside. (See *s.ag.*, fig. 1.) The lateral surface of the posterior end of the ramus in *Baptanodon* is composed of the angular and surangular, the former contributing the greater share. In most of the *Ichthyosaurs* the latter element contributes the greater part.

Angular (*ag.*). — The angular is a long curved bone that forms the lower posterior boundary of the jaw. The anterior end tapers to a point similar to the surangular and disappears between the splenial and dentary just in advance of the anterior end of the surangular. (See Pl. VIII.) The suture between this bone and the splenial posteriorly passes to the inner side. The angular then underlaps the splenial and

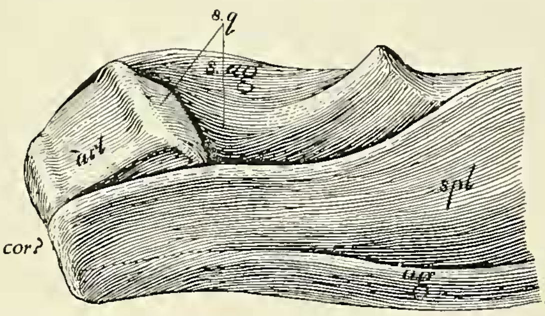


FIG. 3.. Internal view of the posterior end of the left mandibular ramus of *Baptanodon discus* (No. 603). One half natural size. *art.*, articular; *ag.*, angular; *cor.*, coranoid (?); *s.ag.*, surangular; *s.q.*, articulating surface for the quadrate.

coranoid (?) and more posteriorly develops an inner plate that encloses the lower part of the articular.

Articular (*art.*). — The articular apparently is the least understood of any of the elements composing the Ichthyosaurian jaw. Of all the literature to which I have had access I have yet to find an adequate description of this bone. Fortunately the mandible pertaining to specimen No. 878 has both of these elements preserved *in situ*, while the right articular of No. 603 was found nearly in position but has been detached for purposes of study. It is this element upon which this detailed description is based.

As in most reptiles the articular is placed far back in the ramus. In *Baptanodon* it is held in position by the enclosing walls of the angular, surangular and coranoid (?). The angular entirely encloses the lower portion curving up on the inner side, developing even more of an inner portion than is found in the Crocodile. Viewed superiorly the articular is a short solid subrectangular bone (see figs. 4 and 5.) The upper surface is smooth and gently convex transversely, quite flat anteroposteriorly with the exception of an elevated transverse ridge at either end. Posteriorly the end is subtriangular in form the longer side looking downward and outward. This end is somewhat convex from above downward, presenting a slightly roughened surface. The outer lateral surface of this bone is concave from above downward (see fig. 5) and roughened for ligamentous attachment to the surrounding boncs. The inner surfaee is irregularly concave and roughened down to the inferior wedge-like edge. Anteriorly the end resembles that of the posterior view though somewhat dished from above downward, and more compressed transversely. It was this end of the artieular with the surangular that formed the coneave articulating surface (*sq.*), for the quadrate. There is no anterior process or elongation of this bone and in this respect the articular of *Baptanodon* is much shorter than the corresponding element in the Crocodilia.

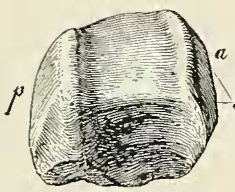


FIG. 4. Internal view of left articular of *Baptanodon discus* (No. 603). One half natural size. *a.*, anterior end; *p.*, posterior end; *sq.*, articulating surface for quadrate.

FIG. 5. Anterior view of same bone. One half natural size. *d.*, dorsal surface; *s.q.*, articulating surface for quadrate; *v.*, ventral surface.

In the posterior position of the articular the manner by which it is retained in the jaw and the part it takes in forming the articulation for the quadrate it is most nearly approached by the articular of *Chelone midas.*

I have observed several figures of the lower jaw of *Ichthyosaurus* which show the articular as a small triangular bone at the posterior end of the ramus lying between the surangular above and the angular below and visible from a side view. In the specimens considered here the articular cannot be seen from a lateral view. The coranoid (?) apparently overlapped the inner margin above the angular.

Coranoid (*cor.*). — Of our knowledge of the extent and nature of the coranoid in *Baptanodon* little can be said at this time. In our specimens it appears as a comparatively thin plate that extends along the inner side of the posterior end of the ramus, lapping over the lower border of the articular, thus assisting the angular and surangular in holding that element in position. Nothing is known of its extent anteriorly.

I am pleased to aeknowledge my indebtedness to Dr. J. C. Merriam for the identification of this element in the material under discussion. On his return from Europe last year he examined the skulls and kindly gave me the benefit of his observations.

Dentition. — The presenee of teeth in the American species has long been suspected by many paleontologists, but until recently[32] there has been no positive evidenee of their existence. The shallow dental grooves combined with the reduced size and undoubtedly loose attachments of thc teeth, will fully account for their

[32] Gilmore, C. W., "Discovery of Teeth in Baptanodon, an Ichthyosaurian from the Jurassic of Wyoming," *Scienee*, N. S., Vol. XVI., No. 414, pp. 913–914, Dec., 1902.

absence in previously discovered specimens. The English form *Ophthalmosaurus icenicus* shows about the same peculiarity in the retention of the teeth. Baur[33] has observed small teeth at the end of the jaws of the (Baptanodontidæ) *Ophthalmosaurus* contained in the private collection of Mr. Leeds in Peterborough, England. Lydekker[34] also speaks of alveoli being present at the end of the jaw in this genus, although the groove is known to extend posteriorly.

In the jaws of No. 878, although the alveolar channels are better preserved than in specimen No. 603, there was not even a fragment of a tooth recovered, but we have evidence of their existence at one time in the faint alveolar partitions preserved on the inner wall of the right dental groove. (See Pl. VIII.)

As suggested in a preliminary paper in *Science* the final exhumation of the jaws of No. 603 revealed more teeth, nine in all, six of which were in the groove of the upper jaw, the remaining three being attached by matrix to the alveolar surface of the lower mandible. With but one exception all of the teeth were lying prone upon the surfaces of the grooves.

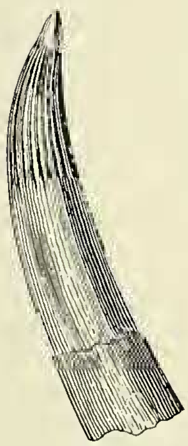


FIG. 6. Posterior tooth of *Baptanodon discus* (No. 603). Twice natural size. The transverse fracture represents the point at which the cross section was drawn.

The largest and best preserved tooth found was cemented to the lower jaw by the matrix just anterior to the forward extremity of the left maxillary. The tooth as preserved (see fig. 6) measures 29 mm. in length, and undoubtedly represents the teeth of the posterior part of the series. The base (see fig. 7) is somewhat angular in cross section, but as the tooth rises it becomes more rounded ending in a circular subacute apex. There is no swelling of the base as may be observed in the teeth of many of the *Ichthyosaurs*. A little more than the upper third is covered with enamel which is impressed with fine longitudinal striæ, between which are intervening depressions. These grooves begin quite abruptly at the base of the enameled surface and extend upward, gradually subsiding before reaching the apex which is smooth. A cross section near the mid portion of the cement covered base shows the tooth to have a somewhat flattened periphery at either end of the line of its greatest diameter. Considering these surfaces as the contact between the tooth and the outer and inner walls of the dentary groove, the tooth would curve in slightly. But it is hard to understand how the shallow and widely separated walls of this groove could ever have been in apposition with the

FIG. 7. Cross section of the same tooth (No. 603). Nearly twice natural size.

[33] Baur, *lit. cit.*

[34] Lydekker, R., "Catalogue of Fossil Reptilia and Amphibia in the British Museum."

teeth it bore. The teeth of the median part of the snout were more slender, but otherwise appear to be identical with the tooth described above. The two most anterior found at a point just posterior to the tip of the rostrum were small, more cone-like, but otherwise similar to those preserved posteriorly. It would appear from the evidence before me that: *Baptanodon was well provided with comparatively small, somewhat slender but functional teeth that extended along the full length of the jaw; the most anterior ones being much reduced.*

The teeth of *B. discus* differ from the one tooth known of *B. natans* in the perfectly smooth enameled surface of the latter.

Thyrohyal (*th.*). — Lying parallel to the posterior part of the right mandibular ramus of No. 878 was a subcompressed rib-like bone which I have considered the *thyrohyal* as described by Owen. There was no evidence of the corresponding bone of the opposite side. Both ends are expanded, more especially the posterior which

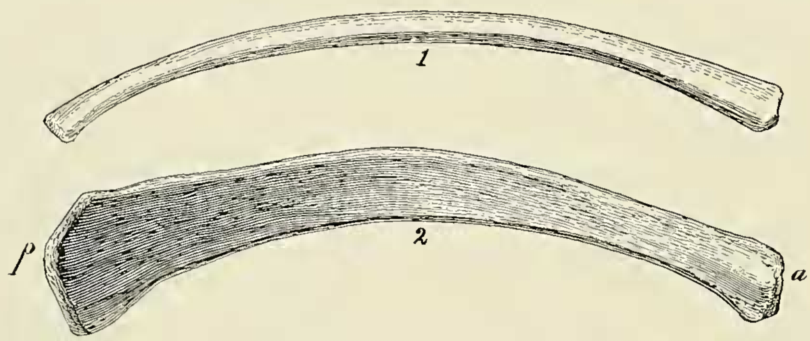


FIG. 8. Right thyrohyal of *Baptanodon discus* (No. 878). One half natural size. 1, view of the inferior border; 2, lateral view; *a.*, anterior end; *p.*, posterior end.

is almost twice the width of the anterior. Pl. XI., fig. 1 (*th.*), gives the position of the element as retained in the matrix.

An inspection of fig. 8 (1 and 2) shows this element as being curved from end to end both vertically and laterally.

MEASUREMENTS.

No. 878.	Greatest length of thyrohyal	191 mm.
" 878.	" width of posterior end	35 "
" 878.	" " anterior "	20 "

THE VERTEBRAL COLUMN.

The material under discussion is not well adapted for a systematic study of the several regions of the vertebral column, and although vertebræ are preserved from the different regions of the back bone, the vertebral series is imperfect in all of the skeletons in this museum. The description of this part of the axial skeleton will be supplemented somewhat by the more complete vertebral series in the collections of the University of Wyoming.

With skeleton No. 603 there are thirty or more vertebræ in various degrees of preservation, but there are none arranged serially. However, every part of the column is represented.

Specimen No. 878 has a series of twenty-one vertebræ extending from the atlas backward. (See Pl. VII.) The first fifteen are in a fair state of preservation but the remaining six are very imperfect. The spinous processes are only preserved in a few instances.

No. 919 which is a much larger individual has a series of ten cervicals commencing with the atlas, a second series of eleven from the anterior dorsal region posterior to the point where the diapophyses become distinct from the neurapophysial articular surface; a third section of eleven posterior dorsals commencing just posterior to the first vertebra having the diapophysis and parapophysis united to form a single node-like articulation. The fourth and last section contains parts of twelve anterior caudals, these show the rapid decrease in the size of the centra posteriorly as previously pointed out by Knight.[35]

The centra in all regions anterior to the extreme caudals are deeply biconcave. These concave surfaces, with the exception of the anterior face of the atlas, begin close to the periphery and slope in rapidly but evenly to the center. In this respect *Baptanodon* may be distinguished from *O. icenicus*, as Lydekker[36] observes of the vertebræ referred to the latter genus. "The cervical region with the cupping of the anterior face of the centrum confined to the central portion, and surrounded by a flattened periphery." There are some isolated centra of this character in the collections of the Yale Museum, labelled as coming from the *Baptanodon Beds* of the Rocky Mountains. From this slight evidence it would appear as though the genus *Ophthalmosaurus* may also occur in this country.

The upper arches in this genus as in all previously described Ichthyosaurians are free from the centra and were united to them by synchondrosis. The centra are always short antero-posteriorly as compared with their breadth and height.

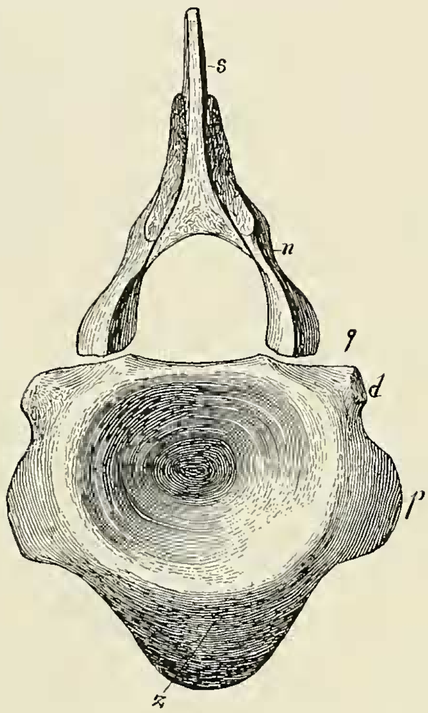
Atlas and axis (*at. and ax.*). — In *Baptanodon* as in nearly all adult members of the *Ichthyosauria*, the centra of the atlas and axis are completely fused, so much so that one would hardly suspect the existence of two vertebræ if it were not for the presence of the two sets of arches upon their dorsal surfaces (see figs. 10 and 26). These vertebræ are represented in all three specimens, Nos. 603, 878 and 919. Those

[35] Knight, W. C., "Some Notes on the Genus Baptanodon, with a Description of a New Species," *Am. Jour. of Sci.* (4), Vol. XV., 1903.

[36] Lydekker, *lit. cit.*

of No. 878 are in the best state of preservation and are the elements from which the text figures have been drawn. Though not found in position (see Pl. VII.) they are readily distinguished from the succeeding vertebræ by their more modified centra and by their dorsal and transverse processes.

Seen anteriorly (see fig. 9) the centrum of the atlas is pentagonal in form, wider



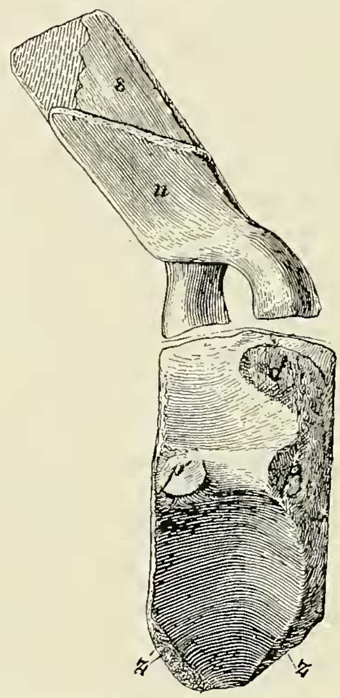


FIG. 9. Anterior view of atlas and axis of *Baptanodon discus* (No. 878). One half natural size. *d.*, diapophysis; *n.*, paired neural arch of atlas; *s.*, spinous process of axis; *z.*, apophysis with which the first intercentrum articulated.

FIG. 10. Lateral view of atlas and axis of *Baptanodon discus* (No. 878). One half natural size. *d.*, diapophysis of the atlas; *n.*, paired neural arch of atlas; *p.*, and *p.'*, parapophysis of the atlas and axis respectively; *s.*, spine of the axis; *z.*, apophysis of the atlas; *z.'*, apophysis of the axis.

than deep and considerably contracted inferiorly. The concavity for the reception of the occipital condyle instead of sloping from the outer margin to the center as in the centra that follow, has a narrow, flattened periphery, which is much enlarged laterally and inferiorly. The cup of the centrum descends evenly, perhaps more sharply, from the superior margin down to the center. The inferior surface presents a slightly rounded subtriangular face which looks downward and forward, its inferior extent reaching nearly to the middle of the coalesced centra. If present it was with this face or apophysis that the first hypophysis or intercentrum articulated. The superior lateral surfaces are quite extensive and curve backward to form the para- and diapophyses. The dorsal surface is about equally divided between the neural canal and the surfaces for the attachment of the pedicles of the neural arch, the two surfaces being separated by narrow antero-posterior ridges.

The lateral surface of the combined centra (see fig. 10) is somewhat concave antero-posteriorly. Superiorly the neurapophysial surface extends outward and coalesces with the heavy articular diapophysis. There is no indication of a diapophysial surface on the axis such as is seen in the axis of *B. marshi* (fig. 26), or the axis of *I. longifrons,* Owen. Just below the diapophysis and separated from it by a non-articular tract is an antero-posterior ridge at either end of which arise articular prominences which represent the parapophysis of the atlas and axis respectively. The parapophysis of the atlas (*p.*) being the larger of the two. The round tubercle like parapophysis (*p.'*) of the axis is placed well posterior on the side of that vertebra. The lateral margin below the parapophysis is concave antero-posteriorly even down to the furthermost extent of the inferior subtriangular part of the centra. I have examined the coalesced centra pertaining to six different Ichthyosaurian skeletons from the Jurassic of North America and have yet to find a trace of the suture uniting the atlas and axis.

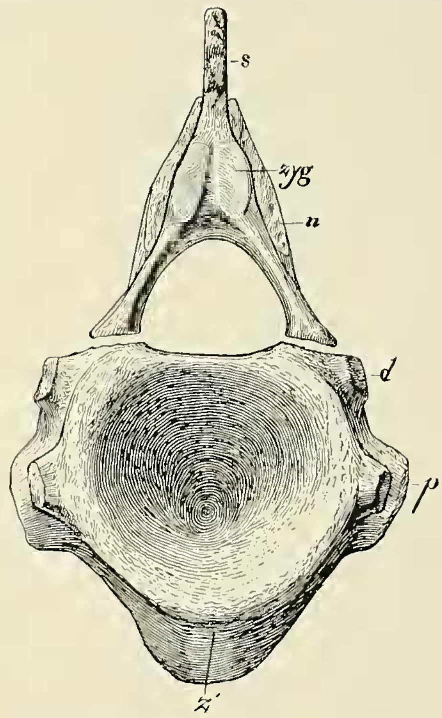
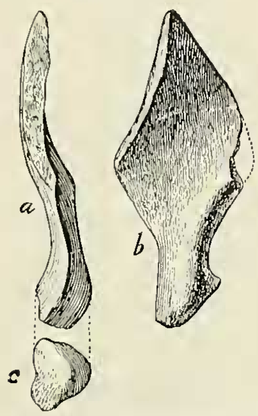


FIG. 11. Posterior view of the atlas and axis of *Baptanodon discus* (No. 878). One half natural size. *d.*, diapophysis of the atlas; *n.*, neural arch of the atlas; *p.*, parapophysis of atlas; *s.*, spine of the axis; *zyg.*, posterior zygapophysis of the axis; *z.'*, apophysis for third intercentrum.

Posteriorly (see fig. 11) the centrum of the axis is deeply concave, the surface) slopes in gradually from the outer margin for half of the radius, thence more sharply to the center. Inferiorly the lower surface is produced into a subtriangular face which looks downward and backward, at a somewhat sharper angle (see fig. 10 than the apophysis of the atlas. This would be the articulation for the third intercentrum if that bone still exists as a separate element in this form. The axis of *B. marshi*, shows no such face, though the apophysis of the atlas appears to still be present. The axes of both No. 603 and 919 appear to be identical with that of No. 878. In these forms it would seem that at least two intercentra exist as separate elements while the one between the atlas and axis has become completely anchylosed to the centra. I have examined the atlas and axis of *B. marshi* (see fig. 26) and find here a still greater reduction in the number of the intercentra. There could not have been more than one retained and it may be possible that all have disappeared. This indicates a higher degree of specialization than has hitherto been found to exist among the Ichthyopterygia. The Triassic form *Shastasaurus*,[37] Merriam has five intercentra while in *Ichthyosaurus* there are but three.

The paired neural arch is the only process supported by the atlas. They extend upward and backward overlapping the lateral basal portion of the spine of the axis and never uniting to form a spine. The left half of this arch was found displaced though in an excellent state of preservation. Viewed from the side (fig. 12, *b*), it is



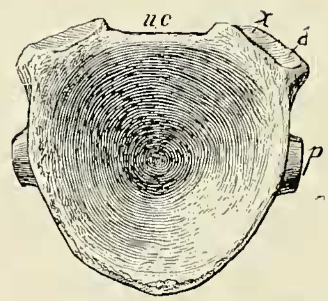


FIG. 12. Left half of paired neural arch of atlas of *Baptanodon discus* (No. 878). One half natural size. *a*, seen anteriorly ; *b*, seen laterally ; *c*, view of distal or articular end.

FIG. 13. Superior view of an anterior cervical of *Baptanodon discus* (No. 603). One half natural size. *a*, anterior *d* and *x* the combined dia- and neurapophysial surfaces ; *n.c.*, neural canal ; *p*, posterior.

FIG. 14. Anterior view of anterior cervical of *Baptanodon discus* (No. 603). One half natural size. *d* and *x*, the coalesced diapophysis and neurapophysial surfaces ; *n.c.*, neural canal ; *p*, parapophysis.

an irregular spear-shaped compressed bone that articulated with the centrum by an expanded subtriangular articular end (fig. 12, *c*). An anterior view (fig. 12, *a*) shows the sinuous curves made necessary for it to fit closely to the process of the axis. The function of these bones appears to be the same as the corresponding elements of *I. longifrons* as described by Owen, which they resemble somewhat in shape and position. This paired neural arch does not develop zygapophyses. The pedicels of the axis as they rise from the surface of the centrum converge and meet above the neural canal to form a well-developed neural spine, the first of the vertebral series. There are no indications of prezygapophyses on the spine of the axis belonging to No. 878, though the process of *B. marshi* shows such articulating surfaces. The posterior portion of the spine is broken away so that its extent antero-posteriorly cannot be determined accurately from our specimens, and it would appear after an

[37] Merriam, J. C., "Triassic Ichthyopterygia from California and Nevada," Univ. of Cal. Pub., Vol. 3, No. 4, p. 75.

examination of the axis of *B. marshi* that the restored spine in fig. 10 is too narrow antero-posteriorly.

Vertebræ Posterior to the Axis. — The succeeding cervicals are very similar in their general form which perhaps is best described as "shield shaped." Fig. 14 is a good example of the cervical centrum and the description given here may be considered typical of the vertebræ of this region.

On the median superior surface is the smooth tract forming the basal boundary of the neural canal (see fig. 13) on either side separated by slight antero-posterior ridges are the shallow roughened neurapophysial surfaces for the attachment of the pads of cartilage upon which the pedicels of the neural arch rested.

This roughened surface is placed largely on the anterior half of the cervical and extends outward and downward becoming confluent with the diapophysis (see fig. 14). The parapophyses are node-like projections placed half way down and on the anterior margin of the centrum, being separated from the diapophyses by a concave longitudinal depression. The position of these two processes remains unchanged as far back at least as the fifteenth vertebræ, as will be seen in Pl. VII.

The anterior vertebræ are broader than high and gradually increase in length posteriorly. From the splendid series of forty-one precaudal vertebræ pertaining to the type of *B. marshi,* Dr. Knight has observed that the maximum length is reached in the nineteenth from the skull.

Continuing back in the column (see fig. 15) it will be observed that the centra remain about the same height but the transverse extent becomes considerably greater, also the articular surfaces of the diapophyses which are confluent with the neurapophysial surfaces in the cervical region become separated. In *Ichthyosaurus* this separation takes place on either the fourteenth or fifteenth vertebra. Dr. Merriam has shown that in one species of *Shastasaurus* it does not occur until the thirty-fifth or later. The point at which this transition is brought about in *Baptanodon* cannot be determined from the specimens under discussion, although we have evidence that they do not separate until the sixteenth or later.[38] (See Plate VII.)

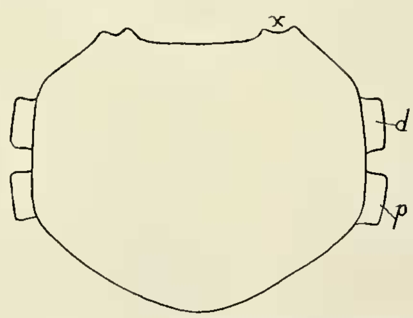


FIG. 15. Cross section of an anterior dorsal centrum of *Baptanodon discus* (No. 603). One half natural size. *d*, diapophysis; *p*, parapophys; *x*, neurapophysial surface.

[38] In the *Am. Jour. Sci.*, Vol. 50, 1895, Marsh figures a vertebra of *Baptanodon natans*, designated as a cervical, The position of the dia- and parapophyses half way down on the side of the centrum at once shows this vertebra as pertaining to the region posterior to the neck. This figure was published a second time in his U. S. G. S. Monograph of the Vertebrate Fossils of the Denver Basin in 1897.

From the cervicals back through the dorsal region the breadth remains greater than the height but the shield-shaped form of the cervical centra gradually changes to what has been called "pear shaped" (see figs. 16 and 17), in the regions here

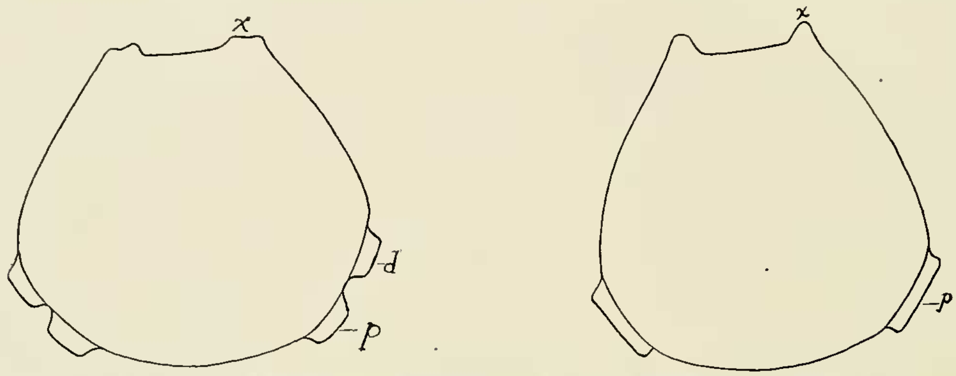


FIG. 16. Cross-section of a dorsal centrum of *Baptanodon discus* (No. 603). One half natural size. *d*, diapophysis; *p*, parapophysis; *x*, neurapophysial surface.

FIG. 17. Cross-section of posterior dorsal or anterior caudal centrum of *Baptanodon discus* (No. 603). One half natural size. *p*, (?) parapophysis; *x*, neurapophysial surface.

considered as middle and posterior dorsals, and this form gradually assumes the compressed elliptical contour seen in the caudals (see fig. 19).

The change in form of the centra brings a corresponding transition of the dia- and parapophyses. These processes gradually move down the side of the centra, until finally only one oblique process remains on the extreme lower side of the centrum. This type probably represents the posterior dorsal region (see fig. 17).

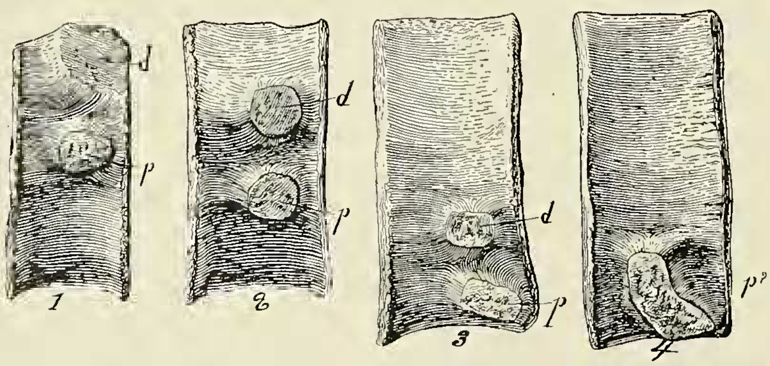


FIG. 18. Lateral view of centra from different regions of *Baptanodon discus* (No. 603). One half natural size. 1, anterior cervical; 2, anterior dorsal; 3, dorsal; 4, posterior dorsal or anterior caudal; *d*, diapophysis; *p*, parapophysis.

In *Ichthyosaurus* Owen described the reduction to a single facet as a union of the two 'pophyses. He thought the diapophysis dropped more rapidly than the parapophysis, thus meeting the latter with which it united to form the single oblique process.

The evidence to which I have had access is not conclusive but it has suggested to me that in *Baptanodon* this is not a union of the two but a development of the parapophyses with a consequent reduction and final passing away of the diapophyses. (Compare 1, 2, 3, 4, fig. 18.) It will be noticed in the cervical (1) region that the diapophyses presents the more robust articular surface of the two; the anterior dorsal (2) shows the two facets nearly equal; the median dorsal (3) indicates an increase in size of the parapophysis with a corresponding decrease of the diapophysis. It will be observed that in all three regions the distance between the facets remains about constant.

In the Triassic genus *Shastasaurus* Dr. Merriam has shown that the parapophyses become obsolete in the anterior dorsal region with a consequent increase in the size of the diapophyses.

The single process in *Baptanodon* gradually decreases in size posteriorly and finally fades away at some point in the caudal region as is shown by fig. 19. Owen has shown that this single process in *I. communis* disappears on the eightieth vertebra and it is at this point that the downward bend or depression of the tail takes place.

Professor Knight has added some important information to our knowledge of the tail of the American form as follows: "In specimen 'T' in the same collection (University of Wyoming) there are forty-six consecutive caudal vertebræ. These are of the usual ichthyosaurian type and represent an animal that had an extremely long and slender tail. The reduction in the size of the vertebræ occurs very near the body and within a distance of a few inches, the vertebræ decrease in diameter over one half. The vertebræ in the area of reduction have reduced margins,[39] in fact in two of them the articulation nearly meets upon the side of the centrum. * * * Although caudal vertebræ from at least a half dozen different animals have been examined, no trace of chevrons has been observed, and the vertebræ lack chevron facets."

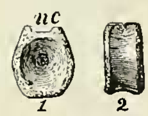


FIG. 19. 1 and 2, end and lateral views of an extreme caudal of *Baptanodon discus*. (No. 603). One half natural size. *nc*, neural canal.

On the anterior vertebræ the neural arches are held together by well developed zygapophyses. The anterior arches have paired zygapophysial facets which unite to form a single median one at some point between the sixth and ninth cervicals. This information is derived from the cervical region of No. 878. The zygapophysial facets have their surfaces roughened indicating as shown previously by Dr. Merriam in the genus *Shastasaurus*, the presence of considerable cartilage.

A number of the anterior cervicals of No. 878 (see Pl. VII.) have the arches and

[39] It occurs to me that these vertebræ with reduced margins may represent the point of divergence of the vertebral column into the lower lobe of the caudal fin.

spines preserved nearly in place, the anterior zygapophyses of these look upward and slightly inward, the planes of which if continued to intersection would meet at an angle of 160° to 170°. The posterior zygapophyses look downward and somewhat outward, being separated by a slight vertical depression.

The neural arches as they rise from the centra are slightly inclined backward. This inclination is continued in the spinous process at a still greater angle. The spines of the anterior vertebræ are greatly compressed laterally, being flattened into a subquadrate plate of bone that is somewhat thickened above. Of the spinous processes of the posterior vertebræ nothing of importance is shown by the material under discussion, though the articular bases of the pedicels must undergo modifications corresponding to those that take place on the dorsal surface of the centra of the several regions. Anteriorly the base is subtriangular in form and somewhat protuberant, but upon the centra where the separation of the diapophysis and neurapophysial surfaces takes place the articular end becomes long and narrow, and rests upon corresponding ridges which rise from the dorsal surface of the centrum. (See fig. 17, *x*.)

FIG. 20. Posterior view of a right dorsal (?) rib of *Baptanodon discus* (No. 603). One half natural size.

Ribs. — Though there are numerous parts of ribs preserved with the different skeletons no complete ribs have been found. Those pieces lying on either side of the anterior vertebra of No. 878 (see Pl. VII.) show the ribs of this region to have been very long and slender. On the left side of the column (*r'*) is about 725 mm. long although both ends are wanting. This evidence appears to indicate a very deep body cavity anteriorly. Corresponding to the form of the anterior vertebræ the ribs have a distinct tuberculum and capitulum. The latter probably as in the other groups of the Ichthyopterygia disappears in the posterior dorsal region. As yet the abdominal splint-ribs so numerous in *Ichthyosaurus* have not been observed in this genus.

Pectoral Arch. — Plate XII., Figs. 1, 2 and 3.

The pectoral girdle of *Baptanodon* is represented in two specimens, Nos. 878 and 919, the former having the most complete arch yet discovered of this genus. Fig. 21 shows the inferior view of the elements as they were retained in the matrix. The girdle pertaining to No. 919 though incomplete has been entirely removed from the matrix and it gives us a good idea of the anterior and superior aspects of this region. (See Pl. XII., figs. 1 and 2.) As mentioned previously this specimen may prove to belong to a different species when more complete material is known.

It will be observed in fig. 21, that with the exception of the clavicles and interclavicle the other elements have been retained in their mutual relations and establishes for all time the relative position of the scapulæ and coracoids of this genus. The position of the clavicles and interclavicle can be determined with a fair degree of accuracy. An examination of the roughened surfaces (*x* and *x*), for ligamentous attachment on the anterior borders of the scapulæ shown best in Pl. XII., figs. 1 and 2, No. 919 evidently indicates the place of attachment for the clavicles. The firmly united clavicles evidently curved up along the anterior borders of the scapulæ and coracoids, being attached to the former by ligaments at *x* and *x*, to the latter by the interclavicle, which fits into a groove on the posterior median side of the

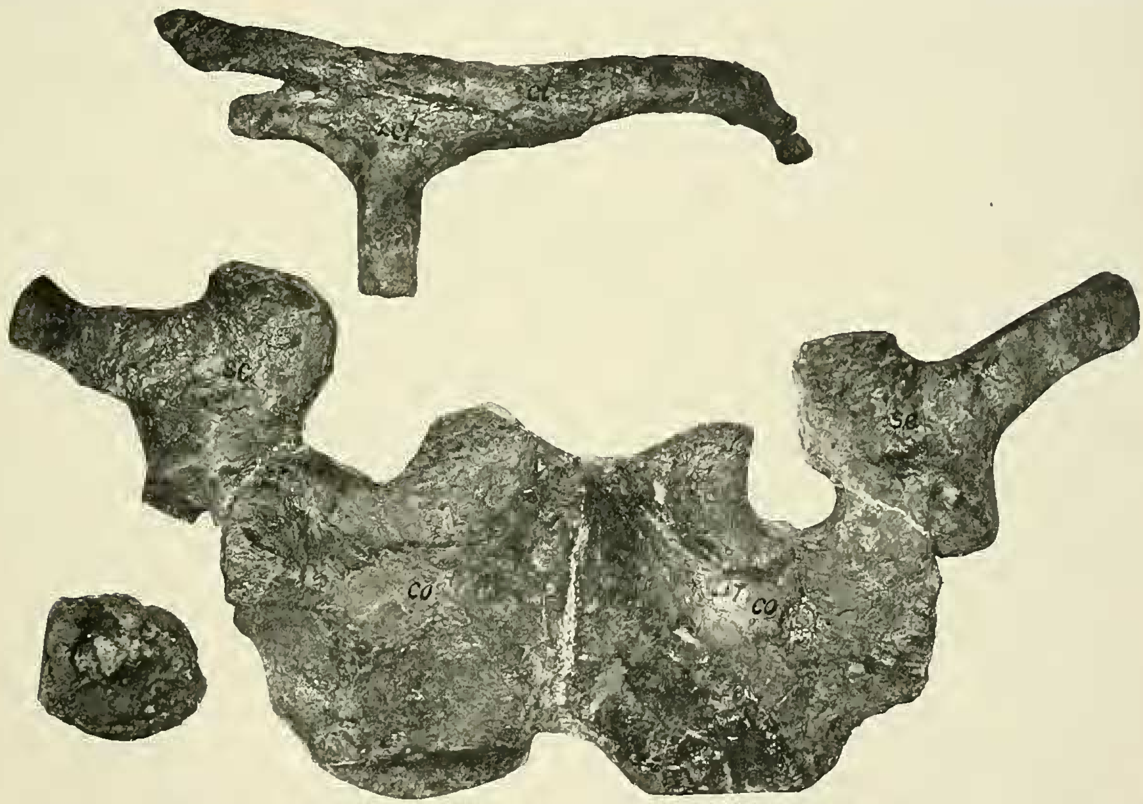


FIG. 21. Ventral view of the pectoral girdle, as found in the matrix. *Baptanodon discus* (No. 878). One fifth natural size. *cl*, clavicle; *co*, coracoid; *h*, humerus; *i.cl*, interclavicle, *sc*, scapula.

clavicles and extends back until its upper excavated surface laps under the anterior median union of the coracoids, the position in extant Lizards, thus forming a brace between the two parts of the girdle. In both specimens the girdle is formed essentially in the same manner as in *Ichthyosaurus*.

Dr. Knight's observation that: "There was no evidence of an interclavicle, and the peculiar union of the coracoids precludes an interclavicle of the regular Ichthyosaurian type. In consequence the interclavicle in Baptanodon must be considered rudimentary or wanting," must have been based upon a comparison of the coracoids of *B. marshi* with those figures of *Ichthyosaurus* which show the interclavicle as lying between these elements anteriorly. The portion of a girdle figured by him appears to be identical in form with the arches under discussion, one of which, No. 878, has a well developed interclavicle making it appear that Knight was mistaken in his interpretation of this region.

Coracoid (*co.*). — The coracoids are broad subquadrangular bones that join one another medially by large elliptical facets. These facets are roughened and were evidently united by a heavy pad of cartilage, the width of which is best shown in Pl. XII., figs. 1 and 2.

The internal or superior surfaces (Pl. XII., fig. 2), are flattened, though both elements are gently inclined toward the median line. The external or inferior surfaces are concave transversely and convex antero-posteriorly. The lateral borders are especially thickened forming a heavy articular face for the scapulæ and humeri. This outer articular end is divided into two unequal faces meeting in an obtuse angle. The more anterior and smaller one of the two is for the scapula, and looks outward, forward and obliquely upward. The larger and posterior surface forms the greater part of the glenoid cavity. It is very slightly convex from above downward and covered with tubercle-like eminences indicative of a heavy pad of cartilage. This articular end is supported by a broad neck formed by a deep notch on the anterior margin and a slight emargination on the postero-lateral border of the coracoid. This anterior notch Seeley suggests, probably corresponds to the foramen found in the coracoids of the Dinosaurs.

The anterior border from the inner notch thickens rapidly as it recedes posteriorly to form the intercoracoidal facet (see Pl. XII., fig. 1). The posterior part is compressed to a thin plate, the border being rounded from the inner angle of the emargination to the median union of the two elements.

The coracoids resemble those of the long-snouted species or Latipinnate form of Ichthyosaurs of which *I. tenurostris* is a good example.

MEASUREMENTS.[40]

No. 878.	Greatest length of coracoid antero-posteriorly	253 mm.
" 878.	" width " " transversely	208 "
" 919.	" " " " "	200 "
" 878.	" " " girdle end to end of scapulæ	770 "

Scapula (*sc.*). — The scapula is a moderately long bone, the upper half being narrow with nearly parallel sides, the lower or articular portion is broadly expanded

[40] Measurements given of No. 878 are made from the right element, which appears to be the least distorted.

antero-posteriorly and is especially thickened on the posterior margins where it enters into the formation of the glenoid cavity. The articulating face for the coracoid joins this border at an obtuse angle.

The scapula extends outward, upward and forward, not backward as Seeley suspected in his original description of the type of *Ophthalmosaurus*. Both arches before me have the scapulæ retained in their natural relations to the coracoids and their position may be considered as absolutely determined. Viewed longitudinally the inner surface of the scapula is slightly concave, as it curves up to lap over the side of the ribs. On the upper free end the inner surface is quite flat, distally the articulating end is concave antero-posteriorly. The anterior border above is gently rounded but as it approaches the articular end it widens into a flattened oblique surface (x) that looks forward and upward. (See Pl. XII., figs. 1 and 2.)

Seeley[41] regarded a part of this border as the acromion process. The oblique surface mentioned above is roughened and I have interpreted it as being the place of attachment for either the ligaments or cartilage which held the clavicles in position. The position of these elements is beautifully shown by a specimen of *I. quadriscissus*, No. 6293, in the Stutgarter collection of which Frass[42] gives a figure.

The scapulæ of our specimens are not notched to fit over the articulating surfaces of the coracoids as figured by Knight but unite by nearly straight articulating faces. An examination of Dr. Knight's specimen, the type of *B. marshi*, convinces me that the articular ends of the scapulæ of that species are not different than those of *B. discus*, but in the former case were crushed so that their true shape and relations could not be accurately determined. The lower surface of the scapula is convex from end to end. Antero-posteriorly the free end is gently convex, but somewhat concave at the expanded articular end. Between the marginal "acromion process" and the articulation with the coracoid the internal border is especially compressed and remains free.

Seeley has best described the humeral articulating border as follows: "The humeral articulation is an expanded triangular thickening of the bone, extending posterior to what would otherwise be an extension of the parallel sides of the free or distal end."

MEASUREMENTS.

No. 878.	Greatest width of free end of scapula	55 mm.
" 878.	" " " articulating "	173 "
" 878.	" length " scapula	248 "

Clavicles (*cl.*). — So far as I am able to learn specimen No. 878 is the first *Ich-*

[41] Seeley, H. G., *Quart. Jour. Geol. Soc. of London*, Vol. XXX., pp. 696–707, 1874.

[42] Frass, E., *lit. cit.*, Plate IV., fig. 2.

thyosaurian from the Jurassic of America to have the clavicle and interclavicle bones preserved. The position of these elements as retained in the matrix is well shown in fig. 21. It will be observed that the upper extremity of the right clavicle as well as the right transverse end of the interclavicle are wanting.

Viewed anteriorly if complete the anchylosed clavicles are bow-shaped, widest at the middle, gradually narrowing as they turn up along the anterior borders of the scapulæ. The ends must have been directed upward, outward and backward to the extent that either clavicle would be opposed to the oblique roughened surface[43] on the inner anterior borders of the scapulæ which look forward and upward. The outer or upper third must have been free from the scapula though lying parallel with the free end of that element.

The left clavicle which is quite complete at its upper end is subcircular in cross-section. The broken end of the right clavicle is somewhat angular in cross-section. On the median posterior side of the blended clavicles is a deep longitudinal groove for the reception of the transverse portion of the interclavicle. The latter is shown in fig. 21 a little removed to the left from its normal place in the clavicular girdle.

Professor H. G. Seeley has pointed out four different ways by which the clavicles unite in *Ichthyosaurus*. 1, clavicles anchylosed or connate; 2, clavicles meeting in the median line; 3, clavicles not meeting but joining by squamous union with the extremities of the interclavicle; 4, clavicles united by a long squamous suture. He adds a fifth in *Ophthalmosaurus*, 5, clavicles united medially by an interlacing suture. He considered these differences of generic value, and the fifth was one of the important characters upon which he based the genus *Ophthalmosaurus*.

A careful comparison of Seeley's figures and description of the clavicles of *Ophthalmosaurus* with those of specimen No. 878 shows many similarities. Although the presence of a suture and the interclavicle wedged in between the ends of the clavicles in the former seems to indicate a distinct difference from the anchylosed clavicles of *Baptanodon* which show no evidence whatever of a suture at the median junction.

Interclavicle (*i.cl.*). —With the exception of the right end of the transverse bar (see fig. 21), this element appears to be complete. It is of the usual "T"-shaped form, though possibly not quite so robust as observed in many members of the genus *Ichthyosaurus*.

The inferior surface of the posterior stem is rounded transversely. The parallel borders of this part as they extend forward diverge rapidly forming a wide triangular

[43] Cuvier in "Ossemens Fossiles" as early as 1824 points out that the scapula of *Ichthyosaurus* has at its anterior edge a prominence which supports the extremity of the clavicle.

plate whose outer apices are produced to form the ends of the transverse bar. This transverse portion lies in a groove on the posterior side of the clavicles and when in position only the stem could be seen from an inferior view of the girdle. (See Pl. XII., fig. 3.) An examination of fig. 21 shows the interclavicle slightly removed to the left from its natural position in the groove of the clavicles.

The upper posterior side of the stem is gently concave from side to side, indicating that it probably underlapped the median ventral surfaces of the coracoids, thus giving support to the forward part of the arch.

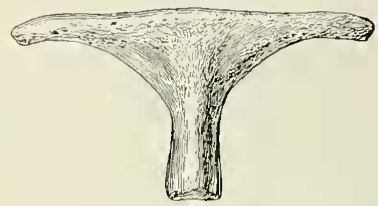


FIG. 22. Inferior view of interclavicle of *Baptanodon discus* (No. 878). One fifth natural size.

Nothing is known of the pelvic girdle at this time.

Anterior Limbs.— Professor Marsh briefly described the fore paddle (probably pertaining to specimen No. 1958) of *Baptanodon* as follows: "In the fore paddle the humerus alone is differentiated. Below this the bones of the forearm, the carpals, metacarpals and phalanges are essentially rounded free disks implanted in the primitive cartilage. The radius may perhaps be regarded as a partial exception, as its free margin is nearly straight and somewhat thinner than the remaining border. There are three bones of nearly equal size in the first row below the humerus. The radius may be identified with certainty by its position. The next bone evidently corresponds to the intermedium [44] and the third or outer one, to the ulna. In the succeeding row there are four subcircular bones, and five in the next series. These represent the carpals. There are six metacarpals, and also six well-developed digits, each composed of numerous phalanges, which are free and nearly circular in form."

Knight has given additional information of the paddle bones in the following lines: "The carpals, metacarpals and phalanges are compressed grooved cylinders the most of which have slightly concave surfaces. The grooves are ornamented with tuberosities for musular attachment. Along the margins of the limb the cylinders have their exterior borders reduced to quite thin edges. Anyone finding the limb of a *Baptanodon* for the first time scattered about in the field would surely try to fit the ventral and dorsal surfaces of the metacarpals in trying to construct a digit."

There is nothing to be added to this description by our material which consists of the proximal end of a humerus (see fig. 21, *h*), and a few miscellaneous paddle bones.

Humerus (*h.*). — Knight describes the humerus of *B. marshi* briefly as follows:

[44] Now considered the ulna, while the succeeding element is identified as the pisiform. Dr. Williston proposes the name "epipodial supernumerary" for the latter.

"Humerus about one third the length of the limb, with a stout twisted shaft that is greatly compressed near the distal end. Planes passed through the articulate ends of the humerus stand at an angle of 50°. The head is slightly rounded and is almost identical with *Ichthyosaurus*. There are three distal facets; but they are not of equal size. The facet for the ulna (see fig. 24, *u*) is the largest, the one for the radius (*r*) next in size and the one opposite the pisiform (*p*) is rudimentary, for that bone was held in cartilage and did not articulate with the humerus. The

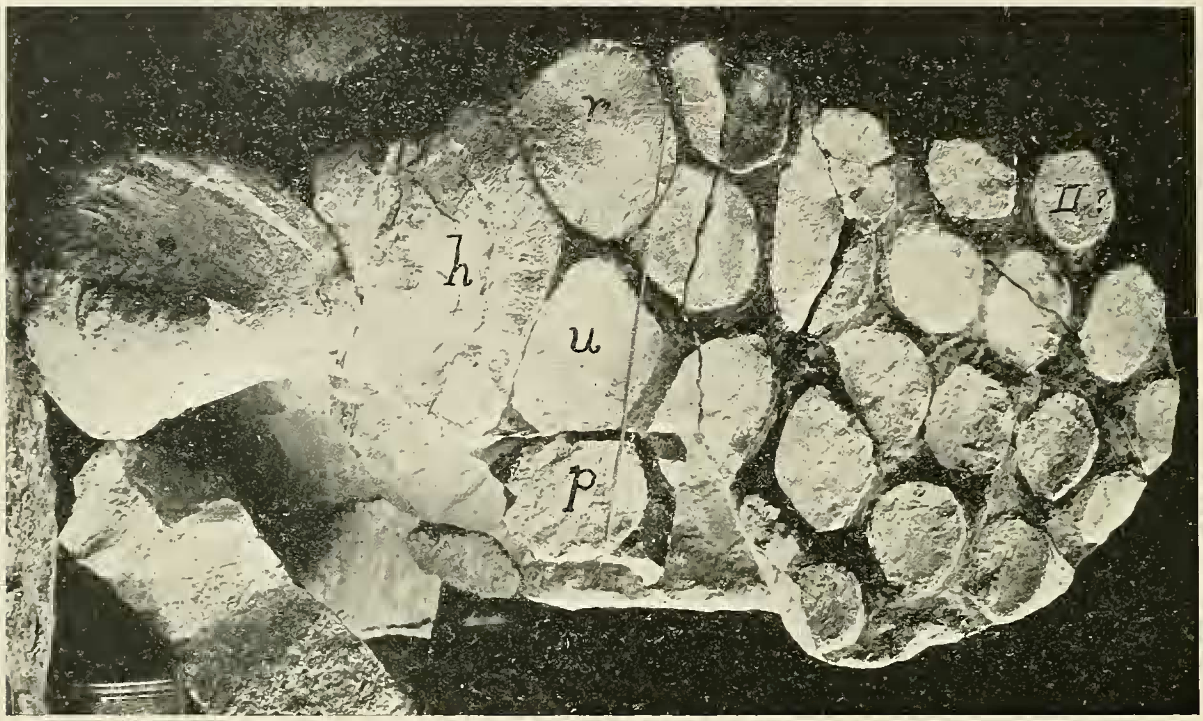


FIG. 23. Superior view of fore paddle of *Baptanodon marshi*, Knight. Reduced about 2½ times. *h*, humerus; *p*, pisiform; *r*, radius; *u*, ulna; II (?) second digit, first one wanting.

facets are elliptical in form, and those opposite the ulna and radius elongated in the plane of articulation."

MEASUREMENTS OF HUMERI PERTAINING TO ENGLISH AND AMERICAN FORMS.

	Greatest Length.	Width Proximal End.	Width Distal End.	Remarks.
No. 1955. Specimen in Yale Museum, *B. discus*......	—	100 mm.	115 mm.	Type of species.
No. 878. " " Carnegie Museum, *B. discus*...	—	115 mm.	—	Distal end wanting.
No. "S." " " Univ. of Wyoming, *B. marshi*.	190	127	130	Type of the species.
No. R. 1307. " " British Museum, *O. icenicus*...	145	—	124	
No. 47885. " " " " "	160	—	145	
Cotype *O. icenicus* in Leeds collection.....	164	115	152	Measurements given by Seeley.

Posterior Limbs. — Professor Marsh in his original description of *B. discus* describes and figures a beautifully preserved hind (?) paddle (see fig. 25) of that species. Having made a personal examination of the extremity mentioned above I find the figure to be a faithful reproduction of the limb, which clearly shows the upper limb bone as having three facets, distally as originally described. However Dr. Knight has observed that the distal extremities of the femora examined by him

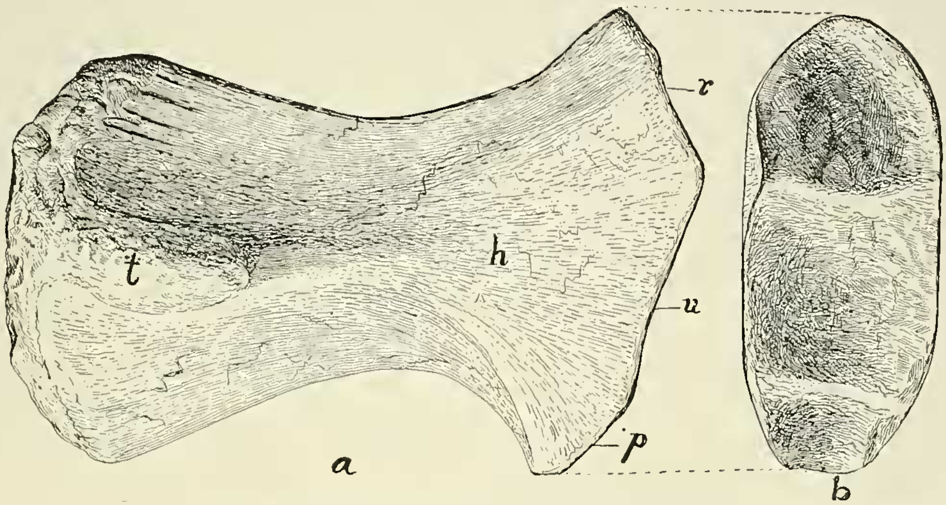


FIG. 24. (*a*) dorsal view of humerus of *Baptanodon marshi* from type specimen. One half natural size. *h*, humerus; *p*, articular surface opposite the pisiform; *r*, articular surface for radius; *t*, trochanter; *u*, articular surface for ulna. (*b*) View of distal articular end of the same. One half natural size.

all have two facets only. This is important and raises the question as to the correct determination of the paddle designated as the left pelvic limb of *B. discus* by Marsh.

This would be an important character for distinguishing the genus *Baptanodon* from the closely allied genus *Ophthalmosaurus*, which is accredited with three facets on the distal end of the femur. A photograph before me of a skeleton of *Ophthalmosaurus* shows the pelvic limb as being much smaller than the pectoral and this would strengthen somewhat the idea that Professor Marsh was mistaken in his interpretation of this extremity.

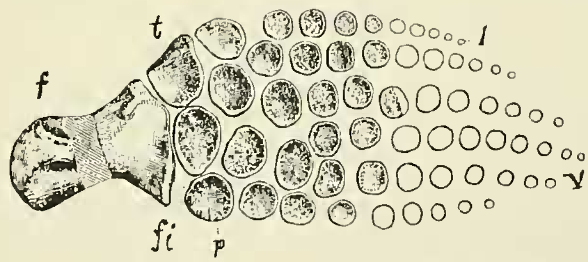


FIG. 25. Left hind (?) paddle of *Baptanodon discus* (No. 1955) seen from below. One eighth natural size. *f*, femur; *t*, tibia; *fi*, fibula; *p*, pisiform or epipodial supernumerary; *l*, first digit; *v*, fifth digit.

So far as I am able to learn there has not been a hind limb of *Baptanodon* found intact and at this time it will be impossible to definitely determine the correct solution of this problem, although from Knight's evidence and the close resemblance of this paddle to the fore limbs known, I am inclined to believe that Marsh was wrong and that the limb figured and described by him as pelvic is really a pectoral extremity. It will be noticed by an examination of Marsh's drawing (see fig. 25) that there is no contact between the proximal and distal portions of the femur (?) which renders it somewhat more difficult to make accurate comparisons.

The additional finger developed in *Baptanodon* and the fact that some of the Ichthyosaurs have as many as ten, is explained by Dr. S. W. Williston as follows :[45] "The additional fingers of the Ichthyosaurs may be also explained in a similar way. The margin of the flipper has become hardened by fibro-cartilage, which by the movement of the fingers was broken into segments, each of which finally took on ossification. A division of the phalanges by segmentation would certainly have to take place immediately in order to preserve the integrity of the paddle as an organ of propulsion. If this explanation be correct, then the additional ossification in the fore arm in the present form, as well as in the carpus, are *not* displaced elements but new ones without homologies."

Discussion of the Genus Baptanodon.

In the year 1879 Professor O. C. Marsh proposed and established the genus *Sauranodon*[46] which being preoccupied was later replaced by the name *Baptanodon*.[47] Since that time all Ichthyosaurian remains from the American Jurassic have been referred to that genus. In his original description Marsh distinguishes *Sauranodon natans* (the type species of the genus) from *Ichthyosaurus* by the absence of teeth, of which he says: "The jaws appear entirely edentulous and destitute even of a dentary groove." This statement is corroborated in a second paper[48] in the following lines: "Since the first species of the present genus was described by the writer, eight other specimens of the same group have been discovered and are now in the Yale Museum. In three of these the skull is preserved, but there are still no indications of teeth, so that we may consider these reptiles as entirely edentulous."

While cleaning the skull pertaining to specimen No. 603 preparatory to study the discovery was made that the animal had teeth,[49] two of which were found

[45] Williston, S. W., "North Amer. Plesiosaurs," Part I., *Field Columbian Museum, Pub. 73*, Geol. Series, Vol. II., No. 1, 1903, p. 70.

[46] Marsh, O. C., "A New Order of Extinct Reptiles (Sauranodonta) from the Jurassic Formation of the Rocky Mountains," *Am. Jour. of Sci.* (3), Vol. XVII.

[47] Maish, O. C., "Note on Sauranodon," *Amer. Jour. of Sci.* (3), Vol. XIX., 1880.

[48] Marsh, O. C., "Limbs of Sauranodon, with Notice of a New Species," *Amer. Jour. of Sci.* (3), Vol. XIX. Feb., 1880.

[49] Gilmore, C. W., "Discovery of Teeth in Baptanodon, an Ichthyosaurian from the Jurassic of Wyoming," *Science*, N. S., Vol. XVI., Dec. 5, 1902.

between the jaws near the end of the snout. Subsequent to this first discovery the jaws were partially separated from one another and seven more teeth were found scattered at intervals along and between the mandibles. Though no teeth were found in the dental grooves of the second specimen No. 878 rudimentary alveolar partitions (see Pl. VIII.) were present near the front together with a few faint sockets at the back of the rostrum.

The finding of teeth in one specimen (No. 603) and evidence of their existence at one time in a second individual (No. 878) led me to believe that dental grooves, if not teeth, would be found in the type of the genus *Baptanodon* if that specimen were thoroughly prepared. Only a little preparation was necessary to demonstrate the existence of well-developed dental grooves on both upper and lower jaws in both types, and just outside of the dental grooves imbedded in the matrix surrounding the rostrum of No. 1952[50] (*B. natans*, type of the genus) a small tooth[51] was found.

The finding of dental grooves and teeth in the types as well as their existence in two individuals preserved in the collections of this museum clearly demonstrates the fact that American Ichthyopterygians of the Jurassic possessed teeth and *were not edentulous* as originally described by Professor Marsh. Thus the one important generic character which has for so long a time separated the American form from *Ichthyosaurus*, and the closely allied European genus *Ophthalmosaurus*, has been shown to be an erroneous determination.

Among the other distinguishing characters ascribed to the type *B.* (*Sauranodon*) *natans* by Marsh, are the number and position of the sclerotic plates of the eye. He says: "The sclerotic ring is composed of eight plates. . . . These plates are not arranged in a nearly flat ring, as in *Ichthyosaurus* but form the basal segment of an elongated cone, as in the eyes of some birds." The badly crushed condition of the skull of No. 1952 makes it impossible for any one to determine with any degree of accuracy the precise number of plates composing the sclerotic circle. The right orbit, which is the better preserved, contains only two plates with the impressions of three others, the intervening space in the ring between the plates and impressions being filled with matrix. The "cone-like" position of these plates is unmistakably produced by crushing. The right orbit of No. 603 shows the sclerotic ring as having been subjected to pressure antero-posteriorly, and here we find the plates assuming the cone-like arrangement, though it is not so exaggerated as in the former case.

[50] Catalogue number of the Yale Museum.

[51] Gilmore, C. W., "Discovery of Dental Grooves and Teeth in the Type of Baptanodon (Sauranodon) Marsh," *Science*, N. S., XVII., No. 436, May 8, 1903, p. 750.

[52] Type of the species, *B. discus*.

The left orbit of the same specimen has the ring nearly circular (see Pl. X., fig. 2) and the plates quite flat, though as Frass has pointed out in life they were probably arranged at somewhat more of an angle. It might be well to mention here that the sclerotic ring in the skull of 1955 [52] (*B. discus*) shows the same flat circular arrangement of the plates observed among most of the members of the *Ichthyosauria.*

The specific characters given by Marsh for separating the two species of *Baptanodon* are quite as superficial as the generic characters just reviewed. Size alone is the only difference of importance, but as in most reptiles these probably continued to grow throughout life. "The breadth of paddles," "elongation of the facial portion of the skull," "slender snout," etc., are illusionary characters and would not serve to distinguish the two species. For example in giving the distinguishing characters between *B. discus* and *B. natans* (type of the genus) Marsh says: "The paddles, also are broader in proportion to their size, than in the type species." It is now definitely understood that the extremities of *B. natans* are unknown. However in the Catalogue of Fossil Reptilia and Amphibia in the British Museum, fig. 5, p. 7, is a figure of the left pelvic limb of *B. natans* (after Marsh from the *Proc. Geol. Society*).[53] The illustration shows the dorsal surface of the limb and is to all intents the reverse view of the left pelvic (?) limb of *B. discus* and accidentally referred to the wrong species.

In a more recent paper[54] the late Dr. W. C. Knight has added much to our knowledge of *Baptanodon* besides giving reasons for considering this genus distinct from *Ophthalmosaurus.*

To correct some inaccuracies in the characters enumerated I will take up the arguments advanced by him and make such comments as access to literature and more complete and better preserved material render possible.

They are as follows:

"In comparing the limbs of *Ophthalmosaurus* and *Baptanodon* one should consider the following points:

1. In *Baptanodon* the humerus is about one third the length of the limb."

1. The absolute length of limb in either form apparently unknown, but in so far as one may judge from illustrations the limbs of the two forms appear to have about the same proportions. Lydekker in the catalogue of Fossil Reptilia and Amphibia in the British Museum gives measurements of

[53] Nicholoson and Lydekker have the same illustration in their "Manual of Paleontology," Vol. II., Fig. 1034, and ascribed to the same species, though (after Marsh and Hulke).

[54] Knight, W. C., "Some Notes on the Genus Baptanodou with a Description of a New Species," *Amer. Jour. Sci.* (4) Vol. XV.

the humerus of *O. icenicus* which agree essentially with the measurements of the American forms.

2. "It has a twisted shaft which is greatly compressed."

2. A humerus pertaining to a specmen of *O. icenicus* preserved in the collections of the American Museum of Natural History, shows the same characters.

3. The distal facets are all unequal in size and one of them is merely rudimentary, besides they are elliptical in the plane of articulation."

3. The humerus of *O. icenicus* has three unequal facets on the distal end, though the one for the pisiform could hardly be considered as rudimentary.

The facets on the distal end of the humerus mentioned above are elliptical in the plane of articulation. Dr. Knight must have drawn his conclusions from a comparison of the humerus of *B. marshi*, with the humerus of *O. cantabrigiensis* a second species described by Lydekker, which has three subequal facets, the longer axis being vertical to the plane of articulation. The former species (*O. icenicus*) however is the type of the genus.

4. "There is also an abnormal number of digits and the arm is much more powerful and larger than found in *Ophthalmosaurus* of equal size."

4. So far as known *Ophthalmosaurus* only has five digits and as Knight has observed the limb of *Baptanodon* was probably more powerful to the extent of being broader, though the other proportions appear remarkably similar

5. "In comparing *Baptanodon* with *Ophthalmosaurus* it will be well to consider that in *Baptanodon* the interclavicle is either rudimentary or wanting."

5. It is now positively known that *Baptanodon* has a well-developed interclavicle. See description, this paper, p. 36.

6. "The absence of the intercentra between the second and third vertebræ."

6. The absence of this bone in other species of *Baptanodon* besides *B. marshi* has yet to be demonstrated, for

it has already been shown that two specimens in this museum, Nos. 603 and 878, have a surface on the infero-posterior margin of the axis as if for the articulation of such a bone. However this element has never been found in place.

7. "The development of large facets upon the interior margins of the coracoids."

7. The coracoids of *O. icenicus* examined by me at the American Museum of Natural History, New York, N. Y., show well-developed surfaces for articulation with one another medially.

Combining the characters given by Marsh and Knight with those shown by the material under discussion the genus *Baptanodon* may now be distinguished by the following characters:

Gen. char.: *Teeth present but loosely attached. Dentition somewhat reduced but extending the entire length of the jaws. Opisthotic reaching and partially enclosed by the squamosal. Reduced number of hypocentra. Vertebral centra forward of the posterior caudals uniformly biconcave. Ribs of the anterior part of the skeleton double-headed. Clavicles firmly united. Well developed interclavicle present. Coracoids without posterior notch and uniting in the median line by large elliptical facets. Humerus with strongly developed trochanteric ridge on dorsal surface and having three unequal facets on the distal extremity, which articulate with three irregular polygonal elements in the epipodial row. All remaining bones of the anterior extremities more or less rounded and retained in persistent cartilage.*

Three species of this genus have been described, of which a brief review is given in the following pages.

Baptanodon natans, Marsh.

Sauranodon natans, Marsh, O. C., Amer. Jour. of Sci., Vol. XVII., 1879.
Baptanodon natans, Marsh, O. C., Amer. Jour. of Sci., Vol. XIX., 1880.
Ophthalmosaurus natans, Lydekker, R., Geol. Mag., Vol. V., 1888.
Baptanodon natans, Lydekker, R., Cat. of Fossil Reptilia and Amphibia in the British Museum, Part II., 1889.

This species, the type of the genus, was based upon a considerable portion of a skull, a number of vertebræ and ribs, and parts of one or more limb bones. As has been shown previously hardly any of the original characters given for this species can be considered valid.

B. natans is typically the smallest species of this group. In fact until the type specimen is properly prepared and redescribed this is the only way by which *B. discus* may be distinguished from this form. The teeth when better known may show specific differences. The one tooth discovered of *B. natans* has a smooth enameled surface as contrasted with striated surfaces of the teeth of *B. discus*.

The type No. 1952 was collected by Mr. W. H. Reed, in the vicinity of Como Bluff, Albany Co., Wyoming, and is now preserved in the collections of the Yale Museum, New Haven, Conn.

Baptanodon discus, Marsh.

Sauranodon discus, Marsh, O. C., Am. Jour. of Sci., Vol. XIX., 1880.
Baptanodon discus, Marsh, O. C., Am. Jour. of Sci., Vol. XIX., 1880.
Ophthalmosaurus discus, Lydekker, R., Geol. Mag., Vol. V., 1888.
Baptanodon discus, Lydekker, R., Cat. of Fossil Reptilia and Amphibia in the British Museum, Part II., 1889.
Microdontosaurus petersonii, Gilmore, C. W., Science, N. S., Vol. XVI., 1902.

This species was based upon a portion of a poorly preserved skull, numerous vertebræ including the coalesced atlas and axis, left coracoid, with the greater portion of the left pelvic (?) paddle and numerous fragments of other portions of the skeleton.

It is with considerable trepidation that I assign the specimens considered in this paper to the species *discus*, but after a somewhat superficial examination of the type I was unable to find differences of sufficient importance to warrant the establishment of a new species as was proposed in a previous paper. The study of the type was superficial to the extent of trying to determine characters from material that has been but little prepared. The parts of the skull exposed only show a small area of the mid-portion of the rostrum and one sclerotic ring; the other parts are either wanting or covered by the very refractory matrix. The characters shown by the parts of the skull exposed together with the atlas and axis and left coracoid are the principal elements upon which my comparisons were based. The great similarity of these elements to the corresponding parts of our specimens prompted me to the present determination.

The type specimen No. 1955 is preserved in the vertebrate collections of the Yale Museum, New Haven, Conn. It was collected by Mr. W. H. Reed in Wyoming.

Baptanodon marshi, Knight.

Baptanodon marshi, Knight, W. C., Amer. Jour. of Sci. (4), Vol. XV., 1903.

In the characterization of this species Dr. Knight distinguished it from all others by the shape and arrangement of the bones of the fore paddle. The two important differences which he considered as typical are the consolidation of three elements into one in the third segment and the development of the abnormal number of digits by a division of the third finger. Accompanying the description is a drawing of the right pectoral limb showing the paddle as retained in the matrix. A photograph of the same paddle is shown in fig. 23.

The paddle probably had six digits but the greatest transverse segmentation of

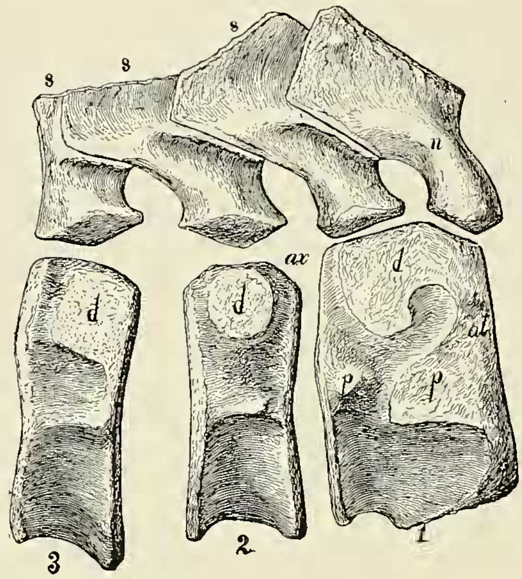


FIG. 26. Atlas, axis and third and fourth cervicles of *Baptanodon marshi* ("S"). Seen from the right side. Type specimen. One half natural size. 1. Coalesced atlas and axis. 2 and 3. Third and fourth cervicles. *at*, atlas; *ax*, axis; *d*, diapophysis; *p*, parapophysis; *n*, paired neural arch.

the parts preserved only shows five elements, although in the original description he says: "The limb that I have been studying and figured differs from the one published by Marsh, inasmuch as the abnormal number of digits do not appear until the phalanges are reached." As the specimen does not show an abnormal number of digits it would be assuming considerable, because of the peculiar arrangement of the bones of the paddle in this form, to say definitely at what point the extra digit, if it did exist, is developed. Moreover it does not appear justifiable to compare this fore limb with the supposed hind paddle of *B. discus* and consider as specific characters differences that are almost certain to exist in the structure of anterior and posterior paddles.

After an examination of the type I should consider the large element (see Fig. 23) as due to a consolidation of two rather than three elements. An offset on the distal border apparently indicates the point of union. This consolidation, instead of being a normal character, may be due to pathological conditions as has been shown to exist in the extremities of the *Mososaurs*.[55]

The species was based upon a considerable portion of the pectoral girdle, with a part of the right fore limb and 41 consecutive vertebræ extending from the atlas posteriorly.

A comparison of the coalesced atlas and axis of *B. marshi*, with the same elements of *B. discus* appears to show differences that would serve for specific separation, *i. e.*, the reduced number of intercentra, shown by the absence of the apophysis on the axis for the third incentrum, and the reduced size of the parapophyses of the third and fourth cervicles. These were certainly not functional in this species. Some other minor differences will be noted by comparing Figs. 10 and 26.

With these exceptions and the arrangement of the bones of the paddle the other parts preserved do not differ materially from the corresponding elements of *B. discus*.

The type is specimen "S" preserved in the Jurassic collections of vertebrates of the University of Wyoming, at Laramie, Wyoming. This specimen was collected by Mr. W. H. Reed from the Baptanodon Beds of the Jurassic in the Northern part of Albany Co., Wyoming, in 1897.

Discussion of the Genus Ophthalmosaurus.

In studying the genus *Baptanodon* it was necessary to review the literature pertaining to the closely allied genus *Ophthalmosaurus*. Having this at hand and because of the great similarity of the two forms it is believed that a brief review of that genus would be appropriate at this time.

The type species is *O. icenicus* founded by Seeley[56] on the greater portion of the pectoral girdle. The important characters by which he distinguishes this genus from *Ichthyosaurus* are the peculiar conditions found in the clavicular girdle, *i. e.*, the separated clavicles, the enclosing of the anterior part of the interclavicle in a groove of the clavicles, and the embracing of the anterior margins of the coracoids by the clavicles.

Further characters were made known by the description of a portion of the fore limb of a second individual which is larger and better preserved than the corresponding elements of the type. These differences are as follows: distal end of humerus articulating with three bones, radius, ulna and olecranon (pisiform of modern nomenclature) and the carpus with a row of four elements.

The characters cited above constitute all of the essential differences given. The somewhat remarkable supposition that the clavicles encircled the coracoids is due

[55] Williston, S. W., "Univ. Geol. Survey of Kansas," Vol. IV., Part I., p. 244.

[56] Seeley, H. G., *Quart. Jour. Geol. Society of London*, Vol. XXX.

to Professor Seeley's incorrect determination of the borders of the coracoid, as has already been indicated by Lydekker,[57] "the one marked intercoracoidal being really the glenoid cavity." This correction is substantiated by the material under consideration in this paper, and the clavicles instead of enclosing the coracoids (made impossible by the articulation between coracoid and scapula), curved up in front of the scapulæ as in *Ichthyosaurus.*

In 1888 in the "Catalogue of Fossil Reptilia and Amphibia in the British Museum," Lydekker gave the following characterization of the genus:

"Teeth present but apparently small, and perhaps confined to the anterior portions of the jaws. Humerus and femur with strongly developed trochanteric ridge on dorsal surface, and articulating distally with three bones, as in *Baptanodon*, which are of irregular polygonal contour. The ulna being pentagonal. Clavicles (typically) separate, with the interclavicle wedged in between them. Vertebral centra of the general type of those of Campyldont subgroup of *Ichthyosaurus.* Coracoid without posterior notch. Humerus and femur apparently (except at distal end) of the general type of those of *I. campylodon* and relatively large in proportion to the vertebræ. In *Baptanodon* and probably also in this genus both pectoral and pelvic limbs relatively wide (or that arising from the intermedium) contains two such rows, with the consequent presence of two centralia."

In 1898 Woodward[58] confined most of the observations made by Seeley and Lydekker, and added important information concerning the pelvic region, *i. e.*, "The pubis and ischium are fused together, leaving a small obturator foramen." Besides, he figures a right pectoral limb which shows that member as being composed of the normal number of five digits.

Combining the characters given by the different authorities the genus *Ophthalmosaurus* may be distinguished by the following:

Gen. char.: *Teeth present but apparently small and perhaps confined to the anterior portions of the jaws. Clavicles (typically) separate with the interclavicle wedged in between them. Coracoids without posterior notch. Humerus and femur with strongly developed trochanteric ridge on dorsal surface and articulating distally with three bones, which are of irregular polygonal contour. Ulna is pentagonal. Pubis and ischium fused together, leaving a small obturator foramen.*

Two species of this genus have been described of which a brief review is given The type specimens are from the Jurassic and Lower Cretaceous of England.

[57] Lydekker, R., "Cat. of Fossil Reptilia and Amphibia in the British Museum." Part II.

[58] Woodward, A. S., "Vertebrate Palæontology," p. 183.

OPHTHALMOSAURUS ICENICUS, Seeley.

Ophthalmosaurus icenicus, Seeley, H. G., Quart. Jour. of the Geol. Soc. of London. Vol. XXX., 1874, pp. 696–707.

This, the type species of the genus, was based upon quite a complete pectoral girdle and portion of a fore limb, the latter pertaining to a second individual. The type was found in the Oxford clay by Mr. C. Leeds, who later submitted it to Professor Seeley for description. The remains of four or five individuals preserved in the collections of the British Museum, and referred to this species by Lydekker have all been found in the Kimmeridge clays which is considered Upper Jurassic, while the type is from Middle Jurassic.

The following specific characters constitute the essential differences as characterized by Lydekker in the Catalogue of Fossil Reptilia and Amphibia in the British Museum.

Sp. char.: "*Larger than the type of the following species. The post-axial facet smaller than that of the radius; and the antero-posterior diameter of the proximal extremity of the humerus less than that of the distal extremity. In the cervical region the cupping of the anterior face of the centrum confined to the central portion and surrounded by a flattened periphery.*

OPHTHALMOSAURUS CANTABRIGIENSIS, Lydekker.

Ophthalmosaurus cantabrigiensis, Lydekker, R., Geol. Mag., Decade III., Vol. V., July, 1888, No. 7, p. 309.

This species was first proposed by Lydekker in a note to the Geological Magazine, the description appearing later in the Catalogue of the Fossil Reptilia and Amphibia in the British Museum. The material upon which this species is based consists of a right humerus from the Cambridge Greensand.

The equal size of the three distal facets of the humerus, and their greatest elongation being vertical to the plane of articulation at once distinguishes this species from *Baptanodon*. Lydekker in his original description adds, "This species may belong to *Baptanodon*." In reality the type of the genus (*O. icenicus*) is more closely allied to that genus.

The type, No. 43989, is preserved in the British Museum.

Sp. char.: "*Typically of small size. The three distal facets of the humerus nearly equal in size, and the antero-posterior diameter of the proximal extremity of the same bone exceeding that of the distal.*"

Relationship and Classification.

In the general outlines of its structure, *Baptanodon* appears very similar to the European genus *Ophthalmosaurus*, although the true relationship of the two genera has long been an enigma to scientists.

In 1888 Lydekker[59] considered *Baptanodon* a synonym of *Ophthalmosaurus* after Baur's[60] suggestion, that: "*Ophthalmosaurus*, Seeley. Vielleicht nicht verschieden von Baptanodon," a view which he abandons later in the Catalogue of Fossil Reptilia and Amphibia in the British Museum.

In 1898 Woodward in his Vertebrate Paleontology, p. 183, observes: "*Baptanodon* from the Jurassic of Wyoming is remarkably similar to the European fossil and perhaps generically identical."

A number of equally eminent American paleontologists have verbally expressed themselves as believing the two genera synonymous.

The presence of firmly united clavicles without suture, and the uniform biconcave cupping of the anterior cervicals, together with the development of a sixth digit in *Baptanodon* are characters which appear to be of sufficient value to warrant the distinct separation of the two genera.

In the reduced size and loose attachment of the teeth, the arrangement of the bones of the anterior extremities, and the retention of the disk-like elements of the paddles in persistent cartilage, these two forms are very similar.

The characters enumerated above indicate a high degree of aquatic specialization and *Baptanodon*, I believe, should be considered the most specialized of the known *Ichthyopterygia*. The closest affinities of *Baptanodon* are with *Ophthalmosaurus*, next approached by *Ichthyosaurus*. In some respects *Baptanodon* is but little more modified to purely aquatic conditions than is found in the earlier genus *Shastasaurus* from the Triassic of California. The humerus of *Baptanodon* is not so broad as that of *Shastasaurus* but it shows greater specialization in the development of three unequal facets on the distal end.

The reduction in the number of intercentra in *Baptanodon marshi*, as well as in *Baptanodon discus*, appears to indicate the most specialized character of the genus. The separated zygapophysial facets in the cervical region, which become single in the vertebræ more posteriorly, are approximated in the Ichthyosaurs.

If Baur's classification of the *Ichthyopterygia* be accepted the family Baptanodontidæ proposed by Marsh would include the two genera *Baptanodon* and *Ophthalmo-*

[59] Lydekker, R., *Geol. Mag.*, Vol. II., p. 309.

[60] Baur, G., "Ueber den Ursprung der Extremitäten der Ichthyopterygia," *Bericht der XX. Versammlung der Oberrhein. geol. Ver.*, Vol. XX.

saurus. The family would be distinguished by the peculiar arrangement of the bones of the paddles, and the reduction of the number of intercentra.

The classification of the genus *Baptanodon* would then be best expressed by the following:

Class, Reptilia; Order, Ichthyosauria; Family, Baptanodontidæ; Genus, Baptanodon.

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EXPLANATION OF PLATES.

PLATE VII. Diagram showing the position of the elements of specimen No. 878, *Baptanodon discus*, as they lay imbedded in the concretion. The irregular line surrounding the bones represents the outline of the concretion. *at.*, atlas; *co.*, coracoid; *cl.*, clavicle; *h.*, humerus; *i.cl.*, interclavicle; *n.*, paired neural arch of atlas; *o.occ.*, occipital condyle; *r.*, ribs; *s.*, spinous process of the vertebræ; *sc.*, scapula.

PLATE VIII. Side view of skull of *Baptanodon discus*, Marsh (No. 878). One fifth natural size. Restored. *ag.*, angular; *d.*, dentary; *j.*, jugal; *la.*, lachrymal; *mx.*, maxillary; *na.*, nasal; *nar.*, narial opening; *occ.c.*, occipital condyle; *pa.*, parietal; *pmx.*, premaxillary; *prf.*, prefrontal (?); *ptf.*, postfrontal; *pto.*, postorbital; *q.j.*, quadrato-jugal; *q.u.*, quadrate; *s.ag.*, surangular; *s.t.*, supratemporal; *scl.*, sclerotic plates; *sta.*, stapes; *spl.*, splenial; *sq.*, squamosal.

PLATE IX. 1. Top view of same skull. One fifth natural size. Restored. *art.*, articular; *ex.occ.*, exoccipital; *fr.*, frontal; *na.*, nasal; *nar.*, nares; *occ.c.*, occipital condyle; *pa.*, parietal; *pin.*, pineal foramen; *pmx.*, premaxilla; *prf.*, prefrontal (?); *ptf.*, postfrontal; *s.ag.*, surangular; *s.occ.*, suraoccipital; *s.t.*, supratemporal; *s.t.f.*, supratemporal fossa; *sq.*, squamosal.

2. Inferior view of skull of *Baptanodon discus* (No. 603). One fifth natural size. Restored. *ag.*, angular; *b.occ.*, basioccipital; *b.s.*, basisphenoid; *d.*, dentary; *ipt.*, interpterygoid vacuity; *occ.c.*, occipital condyle; *pl.*, palatine; *prs.*, presphenoid; *pt.*, pterygoid; *spl.*, splenial; *v.*, vomer. The suture between *ag.* and *spl.* and *cor.*, is incorrectly placed posteriorly.

PLATE X. 1. Side view of skull of *Baptanodon discus*, Marsh (No. 878). One fifth natural size. Seen from right side.

2. Side view of skull of *Baptanodon discus*, Marsh (No. 603). One fifth natural size. Seen from left side.

PLATE XI. 1. Posterior view of skull of *Baptanodon discus* (No. 878). *th.*, thyrohyal.

2. The same, restored. One fifth natural size. *ag.*, angular; *art.*, articular; *b.occ.*, basioccipital; *b.s.*, basisphenoid; *cor.* (?), coranoid; *ex.occ.*, exoccipital; *f.m.*, foramen magnum; *occ.c.*, occipital condyle; *op.o.*, opisthotic; *pa.*, parietal; *pt.*, pterygoid; *q.j.*, quadrato-jugal; *qu.*, quadrate; *s.ag.*, surangular; *s.occ.*, supraoccipital; *s.t.*, supratemporal; *sta.*, stapes; *s.t.f.*, supratemporal fossa; *sq.*, squamosal.

PLATE XII. 1. Anterior view of pectoral girdle of *Baptanodon* (No. 919). One fifth natural size. *co.*, coracoids; *sc.*, scapulæ; *x.*, surfaces for clavicles.

2. Dorsal view of the same girdle. One fifth natural size. Lettering same as 1.

3. Ventral view of pectoral girdle *Baptanodon discus* (No. 878). One fifth natural size. Restored. *cl.*, clavicle; *i.cl.*, interclavicle; *h.*, humerus. Other lettering same as figures 1 and 2.

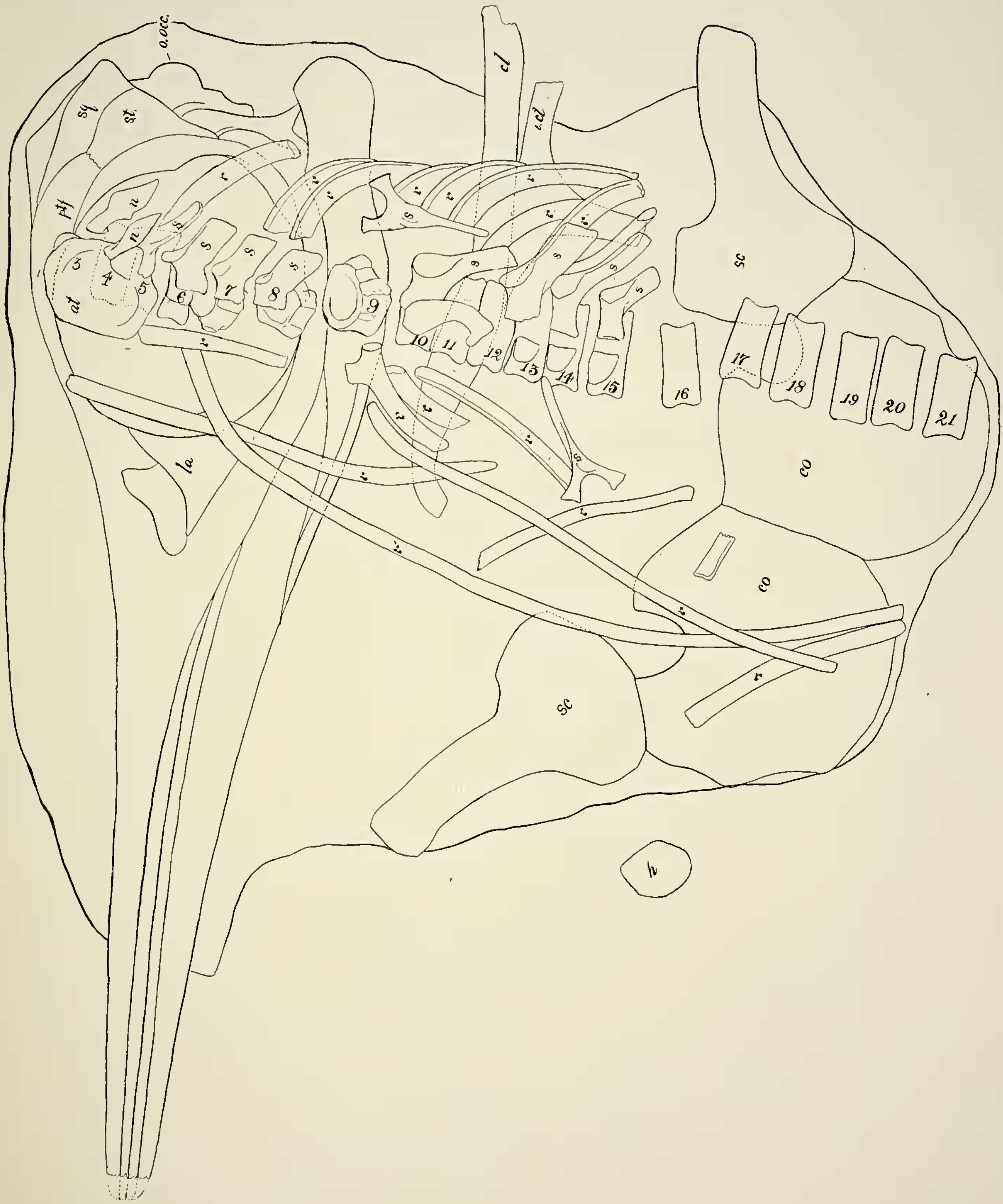
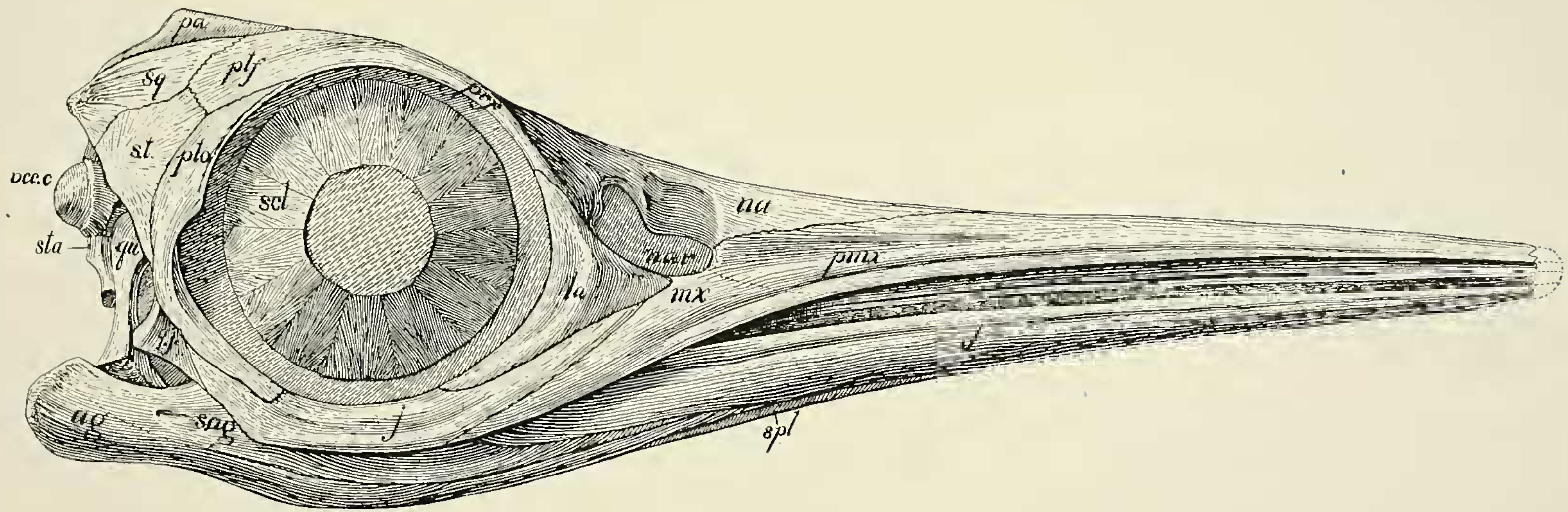
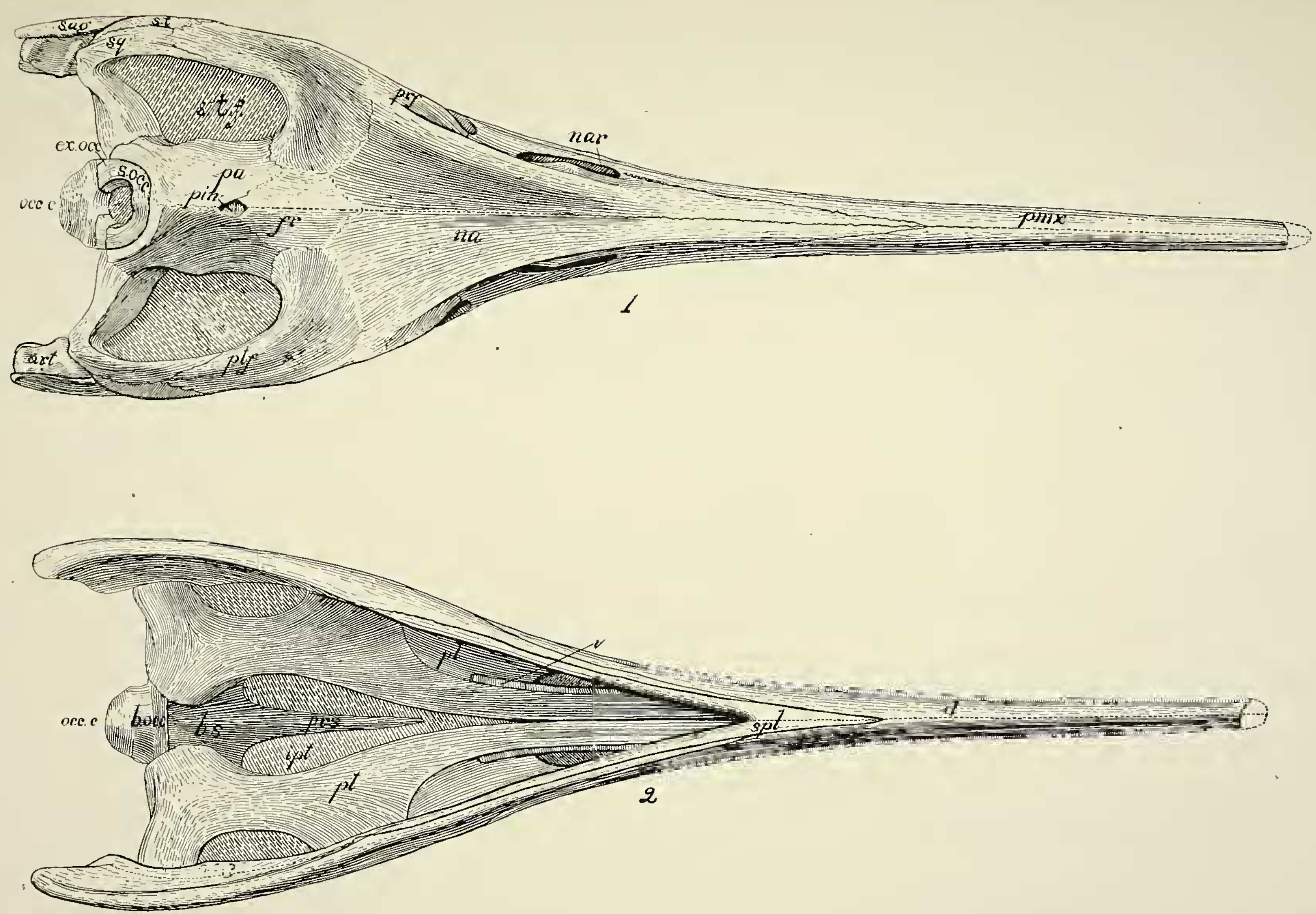


DIAGRAM SHOWING THE POSITION IN WHICH THE ELEMENTS OF THE SPECIMEN OF *BAPTANODON DISCUS* MARSH (No. 878) WERE FOUND IMBEDDED IN THE CONCRETION. $\frac{1}{5}$ NATURAL SIZE.



SIDE VIEW OF SKULL OF *BAPTANODON DISCUS* MARSH (No. 878). $\frac{1}{5}$ NATURAL SIZE. RESTORED.

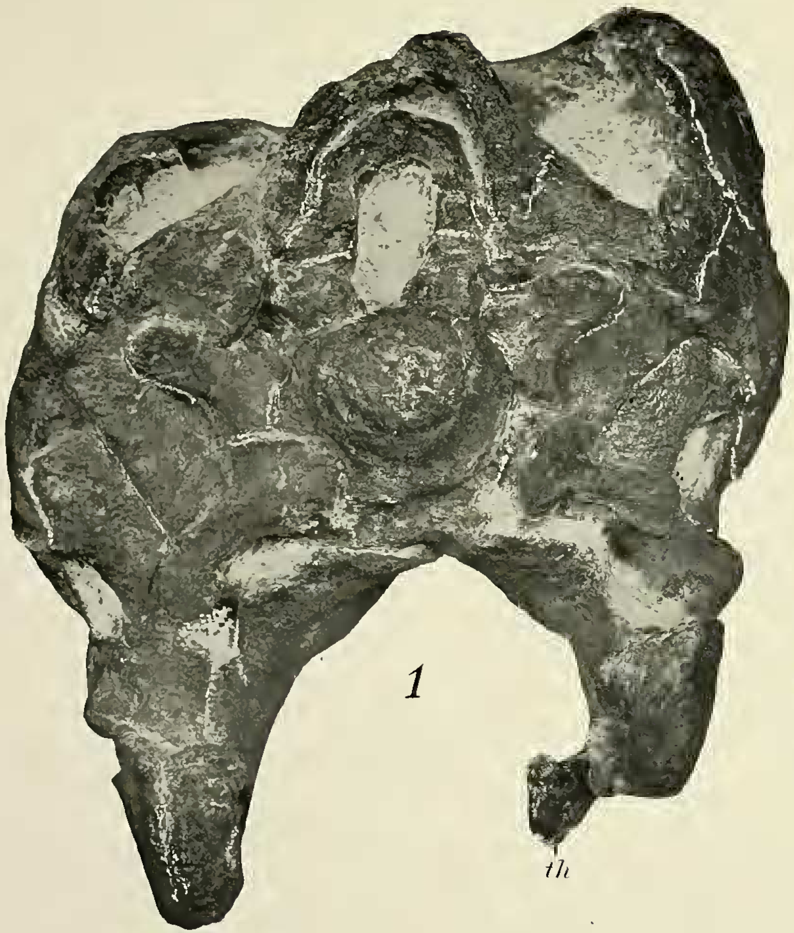


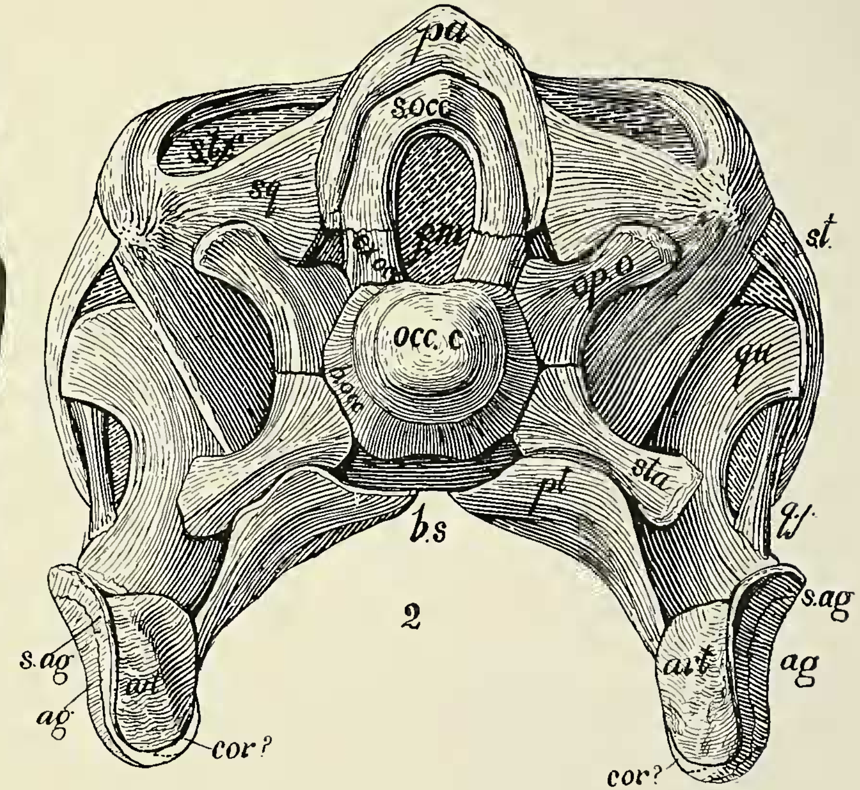
SKULL OF *BAPTANODON DISCUS.* 1, SUPERIOR VIEW (NO. 878); 2, INFERIOR VIEW (NO. 603). BOTH $\frac{1}{5}$ NATURAL SIZE.

1

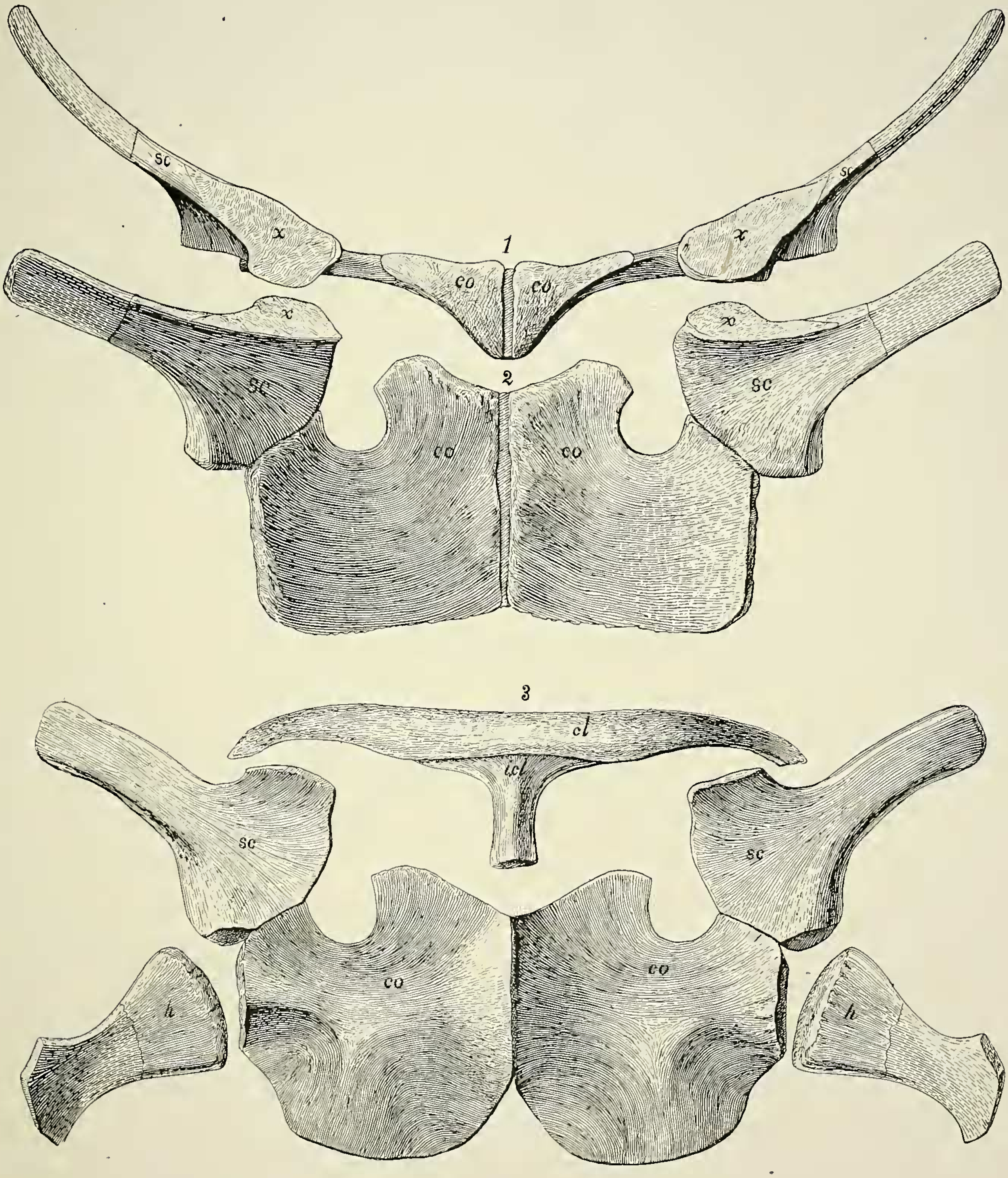
2

SKULLS OF *BAPTANODON DISCUS*. 1, SIDE VIEW (No. 878) $\frac{1}{5}$ NATURAL SIZE; 2, SIDE VIEW (No. 603) $\frac{1}{5}$ NATURAL SIZE.





Posterior Views of the Skull of *Baptanodon discus*. (No. 878) $\frac{1}{5}$ Natural Size. 1, Specimen as Found; 2, Restored.



PECTORAL GIRDLE OF *BAPTANODON DISCUS*. 1, ANTERIOR VIEW; 2, DORSAL VIEW (No. 919); 3, VENTRAL VIEW (No. 878). ALL $\frac{1}{5}$ NATURAL SIZE.